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APPLICABILITY OF REFERENCE BASED APPRAISALS IN ASSESSMENT OF REAL SECTOR INVESTMENT PROJECTS

APLIKACJA METODY REFERENCYJNEJ OCENY PROJEKTÓW INWESTYCYJNYCH W SFERZE REALNEJ

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Summary: Assessment of investment projects in real sector often produces erroneous results. This could be attributed to two major causes: optimism bias and strategic misconception. It is possible to improve appraisals by adoption of external view in project assessment. On the ground of theoretical foundation provided by works of D. Kahneman and A. Tversky, new appraisal procedure based on reference forecasting could be formulated. The proposal calls for a three-stage approach: firstly relevant reference class of similar past projects has to be constructed, then variables subjected to appraisal in particular project need to be calculated across all projects in the established reference class. Finally a mechanism for correcting individual project appraisal results using acquired reference values should be employed. In this paper the method for establishing reference classes and problem of calculation of average values within reference class is discussed taking into consideration both qualitative and quantitative methods. Examples illustrating the application of both methods are provided based either on British proposal for dealing with optimism bias or author's own research into building qualitative reference framework. Finally barriers and limitations in applicability of reference based appraisal in real sector are discussed.

Keywords: reference class forecasting, reference based assessment, real sector investment appraisal.

Streszczenie: Artykuł podejmuje problem poprawy jakości ocen inwestycji rzeczowych w sferze realnej. Błędy w ocenie projektów inwestycyjnych są powszechne i wynikają przede wszystkim z dwóch przyczyn: nadmiernego optymizmu oceniających oraz świadomego systematycznego przeszacowywania korzyści i niedoszacowywania kosztów związanych z inwestycjami. Na podstawie prac teoretycznych D. Kahnemana i A. Tversky'ego można zaproponować zastosowanie metody referencyjnej oceny projektów jako narzędzia poprawy jakości tych ocen. Ocena referencyjna wymaga, po pierwsze, wyznaczenia klasy projektów podobnych i już zrealizowanych, po drugie, wyliczenia w obrębie klasy referencyjnej średnich wartości krytycznych zmiennych podlegających ocenie w badanym pojedynczym projekcie.

Następnie zaś zaproponowania metody korygowania oceny indywidualnego przedsięwzięcia inwestycyjnego w oparciu o uzyskane dla klasy projektów podobnych wartości średnie. W artykule dyskutowane są zarówno budowa klasy referencyjnej, jak i kluczowe zagadnienie sposobu wyliczenia wartości referencyjnych. Proponowane są dwie grupy metod – oparte na podejściu ilościowym i jakościowym. Sposób oceny ryzyka w oparciu o pierwszą z nich zobrazowano przykładami z praktyki brytyjskiej, gdzie metoda ta została przetestowana w praktyce. Druga – jakościowa, opiera się na opracowanym przez autora i przedstawionym w artykule modelu. Ponadto analizowane są główne bariery i ograniczenia wprowadzania metody referencyjnej oceny projektów inwestycyjnych w sferze realnej.

Słowa kluczowe: ocena referencyjna projektów inwestycyjnych, ocena inwestycji w sferze realnej, metody oceny inwestycji rzeczowych.

1. Introduction

Major non-financial investments face many adverse effects. Investing in real sector is accompanied by more risk types than investing in financial assets. This is caused mainly by the more variable environment and diversified activities of companies in real vs. financial sector. Yet existing appraisal frameworks are much better developed in the financial sector. For instance the accord proposed by the Bank for International Settlements has been introduced specifically in order to improve management and assessment of financial activities and risks and adopted by banking sector all over the world [Bank for International Settlements 2010]. On the non-financial side there is nothing comparable. There is no procedure for systematic dealing with differentiated sources of volatility in real sector resulting in failure to properly assess investment projects. Apart from the financial the following major sources of adverse impacts can be identified: market change, events risk, environmental impacts, price movements, demand fluctuation, technology change, legal constraints, natural disasters and others. In real sector the crucial impact of volatility is its effect on investment value. In case of infrastructure it is for instance recognized that 9 out of 10 projects exceed originally planned budgets due to unaccounted for conditions [Flyvbjerg, Skamris Holm, Buhl 2002]. This major failure in the project assessment could be attributed to two different sources: human errors and strategic misrepresentation. Recently a series of articles by B. Flyvbjerg, D. Lovallo and others (e.g. [Lovallo, Kahneman 2003; Flyvbjerg 2006]) has indicated that adoption of external view based on theoretical works of D. Kahneman and A. Tversky on prospects theory might help in overcoming shortcomings of current project assessment methodologies in real sector. The article discusses the pros and cons of adopting external view in project appraisals. The aim is to propose new reference-based mechanism for appraisals whereas individual appraisal should be corrected based on a reference scenario. The methodological approach is as follows: firstly theoretical foundation is given justifying the use of reference-based appraisals, then

two possible ways of developing crucial element of the process – creation of reference classes, are described. Finally the problems that appraiser might encounter while setting up reference based appraisal scenario are discussed.

2. Systemic errors in investment appraisal in real sector

Explaining investment appraisal failures in terms of inaccuracy could be attributed to cases when appraiser bases his evaluation on unreliable and outdated information or uses inappropriate forecasting models. This kind of error could be accepted in cases when investment project is innovative and there is no relevant comparative data. However, if the similar projects have already been conducted, then this explanation seems to be inadequate and testifies to the lack of capabilities on the part of appraiser. Yet we still observe underperformance in project appraisals set in repetitive conditions. The results of cross-country research from the field of infrastructure investments show that appraisal errors are common in all countries [Borkowski et al. 2014], the data for real estate planning [Wang 2006] leads to similar conclusions and cross-sector analysis of public investments [Brealey, Cooper, Habib 1997] reinforces the view that appraisal errors are norm rather than exception. Moreover if errors were truly only result of technical – model or data – shortcomings it would be expected that the inaccuracies were normally distributed with mean value near zero. What we observe in reality is strong shift towards overestimation of revenues from investments and underestimation of expenditure. As an example a review of infrastructure projects could be quoted which shows that railway investments produce an average error of cost underestimation of the magnitude of 44.7%, for road projects it is about 20.4%, and for land-based crossings 33.8% – far away from zero mean value [Flyvbjerg, Skamris Holm, Buhl 2004]. Wherever the source of error is being attributed to limited model capacity, one should understand that models evolve over time and it is very unlikely that they will bear the same intrinsic mistakes for decades because they are being continuously improved [Kiel, Smith, Ubbels 2013]. Appraisal errors should be rather explained by decision makers' tendency to tilt their expectations in one direction only. This could be done either consciously or unconsciously. In the latter case the human nature and psychological effects resulting in biases are guilty but in the former it is clearly political motivation which drives erroneous judgments. One must remember that decisions to fund investment projects are often based on comparison of different proposals competing for the same limited resources. The project which offers better rate of return and lower costs is more likely to win public money. Incidentally the problem of wrong investment estimates in real sector is found more often in investments financed from public rather than private funds. Moreover, over time project appraisers should have learnt from experience, also current data collection techniques allow for more complete databases and modelling techniques have been refined. For those reasons the number of poorly appraised investments should have decreased. We do not

observe this in practice. It seems that real reason behind continued deviation in appraisals in real projects is strategic misrepresentation. The sources of this are psychological and political factors. Psychological explanations describe inaccuracy in terms of optimism bias [Lovallo, Kahneman 2003]. Optimism bias could be described as a tendency to be overly optimistic about key investment variables. In practice it means that two key investment parameters are misinterpreted – costs are underestimated and revenues overestimated. When different variants of specific project are considered, the ones promising more optimistic results are given more weight than the others. This is partially caused by overconfidence of project managers in their own abilities and partially by the tendency to blame negative outcomes on external factors but take credit for the positive ones. Thirdly, project managers and investors tend to treat investment processes as fully controllable, at each stage of the project they believe that all sources of variation are fully accounted for. Than the resulting mistakes in project appraisal come from errors due to "unexpected".

There are however other more important considerations. Project proponents tend to specifically lie about possible cost benefits ratios consciously, falsifying results in order to present projects as more profitable than they really are. This is especially true when appraisal is being done by the investor or project manager or broadly speaking by the same person/group which might benefit from the project development either directly (for instance by earning money for investment development) or indirectly by profiting from the existence of investment (for example local population will certainly support creation of new facilities – health centre, shopping complex, etc., because it will reduce their travel time and improve accessibility). A forecast based on such a plan will therefore automatically become extremely optimistic. There are several studies [Wachs 1989; Flyvbjerg, COWI 2003] that empirically prove that the formula to win project approval is to underestimate costs and overestimate benefits, a mechanism promoting projects that are artificially and misleadingly made to look best on paper.

3. Reference Class Forecasting

Reference Class Forecasting in the investment appraisal is a method for systematic application of outside view in the assessment of investment projects. The key concept is to look at the results of similar, comparable investments and apply findings in the form of measured averages for any variable appraiser is interested in the project being evaluated currently. The method is based on theoretical works on decision making processes by D. Kahneman and A. Tversky [1979]. They prove that while making decisions, individuals often are guided by idealistic and biased assessments. Reference Class Forecasting was developed to compensate for a cognitive bias that was discovered in planning and decision making under the conditions of uncertainty. Looking into the past completed investment projects allows for removal of this

individual bias. Thus they advocate adoption of external (outside) view by measuring average values of variables in question which characterise investment project and correct individual project assessment towards those average values. In investments in real sector the predominant methodology used in appraisals and the one which seems to be method of choice employed within European Union is CBA (Cost Benefit Analysis) [Borkowski et al. 2014]. It should be noted that costs and benefits the calculation of which is key element of the method are especially vulnerable to bias in judgement. In CBA, which compares big number of cash flows associated with different future and thus only estimated monetary values, the possibility of distortion in project estimates due to appraiser bias is very high. Resulting overestimation of individual benefits and costs will cumulate and might lead to deviations exceeding 100%. Practical solution to the problem in the real sector investment assessment is the introduction of reference class based appraisals. The results of any single appraisal should be compared to the appropriate reference class results. In other words, the averages acquired from the analysis of past projects should be used as a reference point in correcting results of any future project estimates. The need for adopting reference class based evaluation technique has already been acknowledged by some planning bodies. In the US the American Planning Association (APA) has recommended that planners shall not only relay on the inside view forecast technique, but instead use Reference Class Forecasting in addition as a way to improve accuracy. British government Treasury Ministry also recommends that estimates of project costs, benefits and duration should be based on data from past projects or similar projects elsewhere [HM Treasury 2002]. In the European Union recently finalized ICEU research project addresses the issue of investment appraisal by advocating the use of reference classes for comparisons [Borkowski et al. 2014].

4. Application of reference-based appraisals

Appraisals based on reference classes should be conducted in following steps:

1. identification of relevant class of past projects comparable to the project in question,
2. calculation of average measures for values which are deemed significant in the individually appraised investment,
3. development of the technique allowing for correction of individually acquired project estimates by average values derived from relevant reference class.

There are very few examples worldwide of application of the reference-based method, which could serve as a blueprint. The only one which has been tested in practice is the UK method for curbing optimism bias based on quantitative approach. The British methodology offers procedure for investment expenditure uplifts depending on the calculated cost level (Table 1).

Table 1. Quantitative based estimated uplifts in British model for dealing with optimism bias

No.	Type of investment	Specific projects included in reference class	Uplift at 50th percentile (%)	Uplift at 80th percentile (%)
1	Road	Motorway Trunk roads Local roads Bicycle facilities Pedestrian facilities Park and ride Bus lane schemes Guided buses on wheels	15	32
2	Rail	Metro Light rail Guided buses on tracks Conventional rail High speed rail	40	57
3	Fixed links	Bridges Tunnels	23	55
4	Building projects	Stations and terminal buildings	4–51	
5	IT projects	IT system development	10–200	
6	Standard civil engineering	N/A	3–44	
7	Non-standard civil engineering	N/A	6–66	

Source: [HM Treasury 2002].

The proposed uplifts represent average errors in the underestimation of investment costs. Within each reference class a group of completed projects was used to establish probability distributions for cost overruns. The figures show that the risk of cost overrun is substantial for all project types. Based on the probability distributions each individually assessed investment can be corrected by applying required uplift. The scale of the necessary correction depends on risk acceptance. For example if appraiser is willing to accept 50% risk of cost overrun, the necessary uplift would be 15% for road, 50% for rail or 23% for fixed link project. For other types of projects due to limited database it was not possible to arrive at probability distribution, therefore ranges of uplifts have to be used. This method allows for elimination of overly optimistic budget assumptions. For example planning 100 million value motorway investment and deciding that costs cannot exceed this preplanned amount with 80% certainty, investor is obliged to prepare contingency reserve of 32% which equals in that case 32 million. The way in which actual calculation of average values for identified significant appraisal factors within any reference class is conducted is in fact technical issue, and many specific methods could be employed (e.g. regression, Monte Carlo, VaR, risk maps, and others). What limits the use of quantitative methods similar to the British proposal is the problem of relevance of the reference

Table 2. Example of qualitative assessment of average values in reference class based appraisal

No.	Analysed factor	Probability	Impact magnitude
1	Change of project during realisation	4.21	3.89
2	Change of localisation	2.61	3.89
3	Corruption	1.64	2.04
4	Nationalisation	0.5	1.11
5	Change in regulatory framework	2.07	2.29
6	Society opposition to project	2.82	2.14
7	Pressure from lobbyist groups	2.46	2.18
8	Environmental impacts	1.86	2.14
9	Lack of payment	2.86	4.39
10	Interest rates movements	1.64	0.86
11	Exchange rates fluctuation	1.86	1.14
12	Untried technology	1.00	1.82
13	Ground and underground conditions	3.00	2.46
14	Bad weather	3.32	2.04
15	Natural disaster	1.39	3.04
16	Building materials price movements	2.79	2.18
17	Fuel prices movement	2.61	1.89
18	Workforce compensation	1.68	2.07
19	Taxation	1.25	1.39
20	Third parties demands	1.71	1.75
21	Accidents	1.46	1.43
22	Inflation	2.07	1.29
23	Need to coordinate with other projects	2.82	2.64
24	Transfer of land delays	2.86	2.86
25	Poor project management	2.79	3.43
26	Wrong timetable for works	3.29	3.64
27	Public authorities intervention during construction	2.21	2.29
28	Delay in decisions and permits	3.46	3.32
29	Mistakes in contract	3.14	3.07
30	Delay of payments	3.57	3.39
31	No possibility of meeting project technical specification	2.43	2.57
32	Poor quality of materials	0.86	1.04
33	Lack of qualified personnel	1.54	1.75

Source: own study.

class. In the UK proposal many rather different projects have been mixed within one class. It is doubtful whether metro links and high speed trains could be counted as projects of similar characteristics. For some groups of projects it could be extremely difficult to find sufficient number of past projects to form a reference class due to limited number of real projects actually completed. There are after all not that many

high speed rails or tunnels developed in one country. And national differences usually make for projects not being transferable thus excluding foreign investments from project databases. In those cases qualitative method for establishing reference class could be used.

In that case the process of reference class definition could be based on qualitative assessments conducted among investors in particular type of project. Example could be provided by looking into reference class evaluation method proposed for appraisals in Polish road infrastructure sector [Borkowski 2014]. The resulting reference class shows reference measures for different factors influencing investment which were recognized as important by road investment sector participants. The reference class has been constructed using the Delphi method. Infrastructure investors were asked to evaluate projects they participated in. The results were obtained between 2012 and 2013 using two-stage Delphi analysis whereas after the first round of evaluation respondents were confronted with average results and asked to re-evaluate their choices. The resulting probability and impact assessment could be considered reliable reference class for this type (road infrastructure) projects (Table 2).

In the above evaluation each factor is characterized by two variables: the probability of adverse event actually occurring and the magnitude of its impact. Evaluation is done using grade scale ranging from 0 to 5 (which is typical scale adopted in probability vs. impact studies). For probability parameter set at 0 the meaning is that there is no possibility for particular event occurring, 1 means that the probability is very low, 2 that it is low to medium, 3 – medium, 4 – high, 5 – very high. Instead of those subjective measures probability ranges could be used. For instance: 0 – 0% probability of adverse event, 1 – 1 to 20% probability, 2 – 21 to 40%, 3 – 41 to 60%, 4 – 61 to 80%, and 5 – 81 to 100%. The ranges could be defined differently as appraisers find it most suitable for particular type of investment. The magnitude scale could also be defined in qualitative way by adopting: 0 – no impact, 1 – little impact, 2 – some impact, 3 – average impact, 4 – high impact, 5 – critical impact. Again each range could be defined more precisely (e.g. using monetary loss value for instance) as it seems fitting to the appraiser. Then, while evaluating individual investment, appraiser could correct obtained individual results by calculating averages through applying weights to individual appraised project result and reference scenario. The more the appraiser believes that his project is specific, the more weight should be given to individual component, the more the project seems to be typical, the more the weight should be given to the value obtained from reference class.

Application of any reference-based appraisal methodology is subject to several limitations which need to be accounted for by appraisers. Major problems in developing reference class based appraisal technique are:

- relevance of projects within reference class (representation and accuracy),
- elimination of bias from reference class,
- use of one vs. many measures,
- transferability.

Transferability problem arises when particular measures within given reference class are based on hermetic models. In general economic assessment is based on models in which inputs are often predefined. When model uses specific and untypical measures, the resulting effect is the lack of transferability. In case of reference classes it means that while assessing particular investment, the more investment specificity is taken into account, the less assessment results could be confronted with reference measure calculated for reference class. This problem is present for instance in discussed above example of British method which was developed for specific local conditions characterizing investments in British infrastructure sector. Especially cost values and proposed uplifts were based on local values for components like: value of time, value of environmental damage, cost of building materials and labour. This results in lack of transferability to other sectors outside infrastructure as well as lack of transferability to other countries, even if project being analysed has similar background. Other problem is created by insufficient database of relevant projects to be used for reference class construction. Not in all segments of investment activity in real sector sufficient number of projects has been realized. In others, some projects are so hermetic due to special financing vehicles used, unusual design etc. that it is impossible to construct reference class. This includes projects which are extremely capital intensive (so called megaprojects). Obviously this problem relates only to very specific projects the characteristics of which fall far beyond typical. It could be argued that all investment projects in real sector maintain some peculiarity, however, in most cases this should not prevent their comparability. But when there are few projects of particular type, there is always a risk that reference class will provide with extreme not average values. In real sector even when there are significant numbers of projects developed in the past, the problem with public disclosure exists. It is typical to treat project assessment data as a trade secret, thus availability of data could be limited. For those reasons instead of looking into particular project investment documentation it might be advisable to build own database using questionnaires distributed among stakeholders of projects from the given field. This will not allow for quantitative referencing but should be sufficient – as the example of Polish road infrastructure demonstrates – for qualitative referencing.

Another problem is the use of one composite measure versus many. The use of a single composite value has an advantage of the simplicity – it is sufficient to relate particular appraised investment to only one number and to calculate only one distribution function. This approach is most useful for the quantitative assessments. But this simplification results also in some disadvantages – it tends to average out extreme values. Wherever it is more relevant to use different reference measures for different identified significant factors impacting investment, qualitative assessments based on many variables should be used instead.

Finally the scale of corrections has to be decided. If the appraisers have significant experience in the field, they tend to rather believe their own numbers than reference calculated averages. One must remember that although in most cases the corrections

result in more accurate measure of the investment project, sometimes they might falsify assessments. The correction is the result of averaging many projects. It could be the case that particular project being appraised happens to be one of the extremes from the whole spectrum of projects within particular class. In that instance the correction will falsify results. Here also the advantage of proposed qualitative approach shows. In qualitative assessment appraiser will correct number of factors not just one. Even if uplifts are misplaced for some factors for majority they will still produce accurate numbers, while in the former case one composite measure will falsify result of the whole appraisal.

5. Conclusions

Use of reference class based appraisals is based on the concept that adoption of external view promises more accuracy in assessment as compared to conventional forecasting which takes an inside view. The outside view on a given project is based on knowledge about actual performance in a reference class of comparable projects. The method promises to bypass two shortcomings of traditional investment appraisal – optimism bias and strategic misrepresentation and could arguably be successfully applied to the appraisal of major investment projects in real sector. The application of the method calls for the establishment of a relevant class of similar investment projects, than for the measurement of average parameters characterizing those projects, and finally for mechanism of adjustment of any individual project to the average. In practice the crucial part is to establish relevant class of similar investments which should show enough common attributes. As demonstrated, this could be done in regard to different types of real projects especially in infrastructure investments. In those types of investments a big enough database of past projects could be build. It is presumed that similar statistically valid samples of projects could be found to build reference classes for other real sphere investments, e.g. hospitals, magazines, housing projects, water supplying solutions, energy production, logistic terminals, shops and possibly many others. Therefore the field for the application of the proposed method is real sector appraisal of investments wherever the sufficient sample of similar projects exists. This limitation is very important. If it is not possible to build a database of similar past investment projects, the employment of a reference-based appraisal cannot be supported. Also the method seems to be less appropriate for the financial sector due to much more dynamic nature of investing in that sector.

The second important issue is the method for establishing average – representative for selected class – values of variables/factors which are used for project assessments. This could be done using many measurement techniques – qualitative as well as quantitative. Examples illustrating both approaches show that selection of relevant method is dependent on data available and appraiser goals. If projects are evaluated on the basis of one abstract composite measure, the quantitative approach seems to be the most promising. In cases where many factors

are assessed, qualitative methods are more useful. The final challenge to eliminating bias from individual investment appraisal is the way corrections are introduced into particular project assessment. This could be done either by uplifts or by averaging out reference and particular assessment values at specific certainty levels. Finally it could be concluded that given the current state of appraisals – noticing that they frequently miss realistic figures – undoubtedly there is room for above proposed type of correcting procedure. The experience of the reference class based appraisals being introduced in practice shows that the method, although still rather young and needing refinements, offers promising results which should lead to improvement in investment appraisal accuracy.

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