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Short report

Measuring the payback of research activities: A feasible ex-post evaluation methodology in epidemiology and public health

Marta Aymerich [a,*], Carme Carrion [a], Pedro Gallo [b], Maria Garcia [a,c], Abel López-Bermejo [a,d,e], Miquel Quesada [a,c], Rafel Ramos [a,c]

[a] Laboratory of Translational Medicine and Decision Science (TransLab Research Group), Department of Medical Sciences, Faculty of Medicine, University of Girona, 17071 Girona, Catalonia, Spain
[b] Department of Sociology and Organizational Analysis, University of Barcelona, Spain
[c] Jordi Gol Research Institute of Primary Healthcare (IDIAP Jordi Gol), Catalan Institute of Health (ICS), Spain
[d] Biomedical Research Institute of Girona, Spain
[e] University Hospital Dr. Josep Trueta, Catalan Institute of Health (ICS), Spain

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ABSTRACT

Most ex-post evaluations of research funding programs are based on bibliometric methods and, although this approach has been widely used, it only examines one facet of the project's impact, that is, scientific productivity. More comprehensive models of payback assessment of research activities are designed for large-scale projects with extensive funding. The purpose of this study was to design and implement a methodology for the ex-post evaluation of small-scale projects that would take into account both the fulfillment of projects' stated objectives as well as other wider benefits to society as payback measures.

We used a two-phase ex-post approach to appraise impact for 173 small-scale projects funded in 2007 and 2008 by a Spanish network center for research in epidemiology and public health. In the internal phase we used a questionnaire to query the principal investigator (PI) on the outcomes as well as actual and potential impact of each project; in the external phase we sent a second questionnaire to external reviewers with the aim of assessing (by peer-review) the performance of each individual project.

Overall, 43% of the projects were rated as having completed their objectives "totally", and 40% "considerably". The research activities funded were reported by PIs as socially beneficial their greatest impact being on research capacity (50% of payback to society) and on knowledge translation (above 11%).

The method proposed showed a good discriminating ability that makes it possible to measure, reliably, the extent to which a project's objectives were met as well as the degree to which the project contributed to enhance the group's scientific performance and of its social payback.

Introduction

The evaluation of research activities largely consists of systematically and rigorously establishing the value of a research project, whether in the planning stage, underway, or completed. It aims to determine the quality and relevance of the project by evaluating its design, execution, and results. If the project is in the planning stage (e.g., when applying for funding), its formal evaluation is termed ex-ante. If it is underway, it is described as ongoing evaluation. If the project has been completed, it is labeled ex-post evaluation. In addition to evaluation of the scientific productivity generated, ex-post evaluation can also seek to determine whether the aims of the study were fulfilled and the extent to which their results can be translated into health and/or social benefits (Almeida & Báscolo, 2006; Hanney, Mugford, Grant, & Buxton, 2005; Lavis, Ross, McLeod, & Gildiner, 2003; Merkx, van der Weijden, Oostveen, van den Besselaar, & Spaapen, 2007). However, sufficiently accurate and accepted methods to evaluate such a multidimensional construct have yet to be developed. Thus, it comes as no surprise that diverse conceptual models have been proposed in the literature (Adam & Permanyer-Miralda, 2009; Meagher, Lyall, & Nutley, 2008).

Most ex-post evaluations of research funding programs are based on bibliometric methods, that is, on quantifying and

* Corresponding author. Tel.: +34 972 41 8285; fax: +34 972 41 9617.
E-mail addresses: marta.aymerich@udg.edu (M. Aymerich), carme.carrion@udg.edu (C. Carrion), pgallodep@ub.edu (P. Gallo), mgarciagil.girona.ics@gencat.cat (M. Garcia), alopezbermejo@idibgi.org (A. López-Bermejo), mquesada.girona.ics@gencat.cat (M. Quesada), rramos.girona.ics@gencat.cat (R. Ramos).

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classifying the academic papers resulting from funded activities, and eventually on comparing this output with that achieved by other projects or research teams. Although this approach is widely used, it only partially examines the project's contribution, namely, its primary scientific output. Among the models that aim to examine a project's impact more comprehensively (Davies, Nutley, & Walter, 2005; Yazdizadeh, Majdzadeh, & Salmasian, 2010), the most commonly used approach has been that developed at Brunel University (Buxton & Hanney, 1996), which takes into account resources (inputs), research processes, primary outputs, dissemination, secondary outputs and applications, and benefits or final outcomes provided by the research. This model has been successfully applied by means of different methodologies (Berra & Pons, 2006; Hanney, Grant, Wooding, & Buxton, 2004), but has hardly been developed further, for example to create more feasible instruments like questionnaires to survey researchers (Hanney, Davies, & Buxton, 1999; Kwan et al., 2007). Other models and their applications have followed (Brutscher, Wooding, & Grant, 2008; Kuruvilla, Mays, Pleasant, & Walt, 2006), most notably the Return of Investment (ROI) model from the Canadian Academy of Health Sciences (CAHS), which incorporates several indicators for the following five payback model categories: advancing knowledge, capacity building, informing decision making, health impacts, and broad economic and social impacts (CAHS, 2009). Overall, the aforementioned models have been designed for large-scale projects with extensive funding.

A network center for research in epidemiology and public health comprising more than 40 research groups working throughout Spain conducted an intramural competitive process to allocate funds for small research projects and other related activities (e.g., training and short internships). The scientific areas covered by these projects included preventive measures among the immigrant population, new socio-demographic patterns in emerging diseases under poverty and inequality, health status among children and adolescents, or domestic violence and mental health. The allocation process followed an ex-ante evaluation of the relative quality, foreseen impact and feasibility of the various proposals received. Two consecutive annual calls – 2007 and 2008 – were launched to fund small projects with the potential of stimulating mobility among research groups, the design of new collaborative projects, additional support for ongoing collaborative projects or knowledge dissemination activities, amongst others. The total budget allocated to these purposes was €808,344 in 2007 and €1,244,445 in 2008.

We performed an ex-post evaluation of the projects awarded funds in 2007 and 2008 using an instrument, developed in-house, designed to assess both the degree of fulfillment of the project's stated objectives and the benefits to those research teams that received funding. The objective of this paper was to describe it and to test the reliability of the instrument in terms of internal consistency, and to test its discriminating ability. Additionally, we aimed to highlight the value of projects as measured by enhanced research capacity, knowledge translation, and potential healthcare benefit.

Methods

The ex-post evaluation exercise started in 2009 and involved two phases (Fig. 1): an internal phase that used a questionnaire to query the principal investigator (PI) on the outcomes and potential impact of each project, and a second questionnaire addressed to external reviewers with the aim of assessing (by peer-review) the performance of each individual project. The University of Girona Vice-rector of Research deemed no ethical approval was necessary for this study or the study leading to this paper as neither could imply any physical or psychological risk to human subjects. However, we follow a code of good scientific practice (CBPC-PRBB, 2007). It should be highlighted that confidentiality was guaranteed and external reviewers did not report any kind of conflict of interest.

Design of the questionnaire for the ex-post evaluation

For the internal phase, we designed a specific questionnaire for PIs to report on the results of funded projects as well as on the research group's outcomes over the last three years. In order to gather information on the project's social payback, the questionnaire incorporated items from previously developed models (Berra & Pons, 2006; Buxton & Hanney, 1996; CAHS, 2009). Benefits were categorized into three areas, namely research capacity, knowledge translation, and potential healthcare benefits. To address the project's social payback, the questionnaire to the project's PI included a comprehensive list of benefits which the project could have contributed in terms of research capacity and knowledge translation, or could contribute in terms of potential healthcare benefits. The questionnaire was sent by email to all project PIs and data gathering was also possible by email communication.

For the external phase, we designed a second questionnaire to evaluate the extent to which the project's objectives have been met

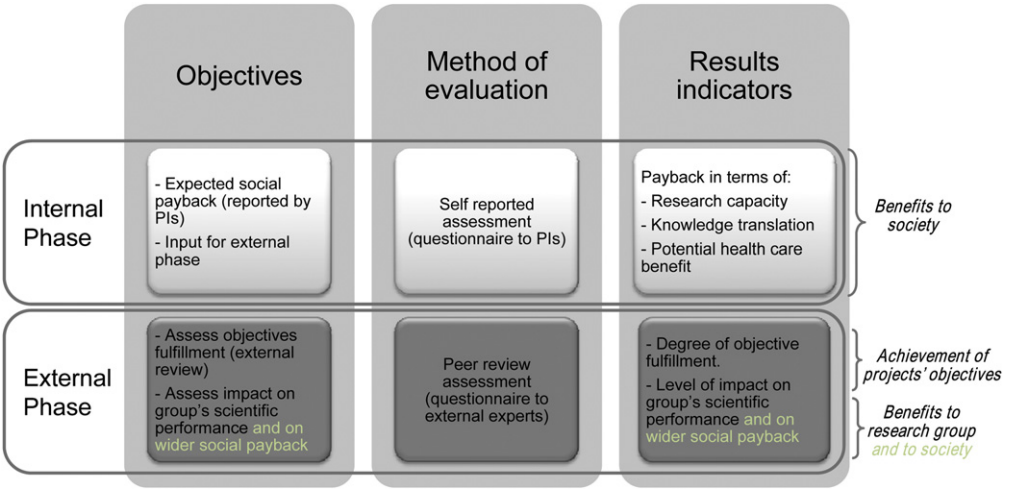

Fig. 1. Overview of study phases.

and what payback had been yielded by each project in terms of its impact on the group's scientific performance. To address the fulfillment of objectives and impact on the group, we designed questions primarily dealing with aspects included in the literature about ex-post assessment of research grants (Merkx et al., 2007; Rons, De Bruyn, & Cornelis, 2008). Thus, the objectives fulfillment component included items such as planned versus achieved outputs, reported changes in original objectives, adherence to schedule, budget execution, and maintenance of the collaboration between groups throughout the project. Additionally, we aimed at capturing the relevance that funded projects had on the groups' scientific performance, as measured by the existence of new collaborative projects, researcher's mobility or knowledge dissemination, amongst other indicators, when compared to the research group's scientific performance in the past. External evaluators in this phase rated whether the funded project represented a contribution of $\leq$25%, 26–50%, 51–75%, or $>$75% (accounting for the abovementioned indicators).

Peer evaluation and scoring

Ten reviewers carried out the external phase of the ex-post evaluation process, and were chosen due to being experts in such fields as research evaluation, management (hospital or research), clinical medicine (hospital or primary care), epidemiology and public health, or biomedical research (basic, clinical, or public health). We consider this transversal multidisciplinary profile especially appropriate for ex-post evaluation exercises that aim to evaluate not only whether the objectives of the project were achieved but also the extent to which the results can be translated to the clinical and/or social contexts. Each project was independently evaluated by two experts, by responding to the external phase questionnaire.

The external phase questionnaire consisted of 17 closed questions. Five of them addressed the extent to which the projects' objectives were met. The remaining 12 questions addressed impact on the research group as well as wider social payback. Each question was accompanied by four possible answers in a Likert scale, a quantitative value being assigned to each answer: minimum 0 points, intermediate values 1 and 2 points, and maximum 3 points. This scoring system has proven valid to determine the allocation of funds for research (Sánchez, Solans, Millaret, Berra, & Pons, 2006).

Additionally, at the end of the questionnaire, the external experts were asked to qualitatively assess the extent to which the project's objectives had been achieved ("Totally", "Considerably", "Not much", or "Not at all"); and the magnitude of its benefit ("Maximum", "Considerable", "Little", or "None"), both to the research group and to society at large. The two experts' overall qualitative assessments in the peer evaluation of each project were combined into a single assessment. Thus, when assessments coincided, the project was classified in the category assigned by both experts. When the two assessments significantly differed a third expert, blind to the previous evaluations, assessed the project and the three qualitative assessments were combined into a single one following criteria already described elsewhere (Sánchez et al., 2006).

Statistical analysis

The answers to the internal and external phase questionnaires were transferred to a database purposefully designed for this evaluation exercise. Data were analyzed using SPSS 15.0 (SPSS Inc., Chicago, IL, USA).

Descriptive statistics were compiled for the internal phase results regarding each project's social payback, namely research capacity, knowledge translation, and potential healthcare benefits as well as for the results of the items on the external phase questionnaire. Likewise, the reliability and the discriminating ability were analyzed. Since the questionnaire aimed to measure two different components, namely "objectives fulfillment" and "benefit conferred or payback", the results of the two were analyzed and reported separately.

In order to assess the reliability of the questionnaire we analyzed its internal consistency, which indicates the degree of homogeneity among items that allows for the calculation of a total score. To achieve this aim, we used the Cronbach's alpha coefficient ($\alpha \geq .7$ to be considered acceptable). Previously, an exploratory factor analysis was performed to ensure unidimensionality. Parallel analysis (Timmerman & Lorenzo-Seva, 2011) with principal component analysis as extraction method and oblique rotation was the approach used to assess dimensionality.

To evaluate the discriminating ability, we studied the distribution of the answers in terms of floor and ceiling effects, which occur when values cluster around the lowest or highest possible values, respectively; floor and ceiling effects lower the discriminating ability of the evaluation process.

Finally, we used nonparametric tests (Kruskall–Wallis test) to compare the overall qualitative assessments with the quantitative scores. Significance was set at 0.05 for all tests.

Results

The network center for research in epidemiology and public health funded 91 projects in 2007 and 126 in 2008. The questionnaire for the internal phase of the ex-post evaluation process was sent in July 2009 to all PIs of funded projects. A total of 44 questionnaires were not returned (21 projects from 2007 to 23 projects from 2008), and were thus not included in the evaluation process. However, the budgets range of the unevaluated projects was not different from that of the projects evaluated.

A total of 173 projects (70 from 2007 to 103 from 2008) were evaluated by means of both the internal and external phases. This represents 79.7% of all funded projects. In 10% of the cases ($n = 18$) the two external experts disagreed and a third assessor resolved the discrepancy as described in the Methods section.

Achievement of projects' objectives

Factor analysis ensured sufficient unidimensionality since all of the items had moderate to strong loadings (ranging from 0.40 to 0.81) on one component. It explained 58.7% of the total variance. The internal consistency was acceptable (Cronbach's $\alpha = .7$). Regarding discriminating ability, only 1.7% of the values ($n = 3$) clustered around the lowest quantitative value, and none of the projects received the maximum score.

An overall qualitative score was attributed to each project on a "Totally, Considerably, Not much, or Not at all" Likert scale. A total of 173 projects were assessed regarding their fulfillment of objectives: 43% of projects were considered to have fulfilled their objectives totally, 40% considerably, 12% not much and 5% not at all. This overall qualitative score results from a more detailed assessment of particular items in each project as regards the fulfillment of its original aim. Items included planned versus achieved outputs, adherence to schedule, budget execution, collaboration among groups within the same project, and changes made to the project's original objectives.

In order to finely discriminate between projects within each qualitative category, we designed a questionnaire where the items could allow for a numerical transformation, as explained in the methods section. Thus, the qualitative assessment is the criteria for

grouping of data and then the quantitative data is compared. Table 1 shows mean values and confidence intervals for each qualitative category. Comparing categories two by two, we found statistically significant differences between all categories, except between the categories "Not very much" and "Not at all". This finding shows that the instrument is capable of discriminating not only between projects that meet their objectives and those that do not, but also between those meeting them "Totally" and "Considerably".

Benefits to the research group and to society at large

Benefit to the research group was evaluated by assessing the impact on research group's scientific performance. Factor analysis revealed the importance of more than one component or domain, that is, it did not ensure unidimensionality. Reliability in terms of internal consistency was low (Cronbach's $\alpha = .5$). For this reason, results are presented separately for each question rather than as a global quantitative score. Quantitative scores were only used to test discriminating ability, and the results showed that only one project (0.6%) received the lowest quantitative score and none received the highest score.

Funded projects had a variable impact on research group's scientific performance depending on the project's purpose. We observed a high impact (above 75%) among projects that targeted an increase in researchers' mobility, in new collaborative projects, and in promoting some research methods development. Overall moderate to high impact (51–75%) was achieved by projects that promoted research translation activities. Finally, low to moderate impact (26–50%) was attained by projects that aimed at supporting already existing collaborative projects in the group.

In the analysis of a project's social impact, we took into account the benefits reported by PIs during the internal phase of the ex-post evaluation process.

Table 2 shows that the development of new research projects was the most frequent benefit reported by PIs (17.7%), followed by training new researchers (15.3%), the potential to improve prevention (13.6%), the creation of collaborative networks (12.9%), and the potential to improve diagnostic processes (10.2%). At the other end of the spectrum, only 0.3% of PIs reported benefits in terms of patents registered and spin-offs created, followed by clinical trials, demonstration projects, or interventional studies (1.1%), and observatories, green papers, health plans, or similar outputs (1.7%).

Regarding the overall qualitative assessment, external reviewers rated the payback of the projects as being "Maximum" in 26% of the cases, "Considerable" in 56%, "Little" in 16%, and "None" in 3%.

Discussion

This ex-post evaluation approach considered two distinct constructs. We sought to determine the extent to which the projects evaluated fulfilled their objectives, and the extent to which they could provide benefits both to the research group and to society at large. Our design comprised two phases: an internal phase in which the PI responded to a questionnaire, and an external phase in which another questionnaire was answered by expert peers. We used this two-phase ex-post approach to evaluate 173 small-scale projects funded in 2007 and 2008 by a network center for research in epidemiology and public health.

The evaluated projects fulfilled their objectives "Totally or "Considerably". Furthermore, the external reviewers considered the projects could mostly yield "Considerable" payback. It has to be pointed out that there was good agreement between expert peers in the evaluation (only 10% involved a discrepancy needing to be resolved by a third assessor).

The funded research activities were socially beneficial, according to PIs' reported outputs and opinions. Their greatest payback was on research capacity (50% of the benefits to society) but also on the translation of knowledge (at least 11%), with actions to develop new methods yielding the greatest impact in this area. Moreover, PIs are confident that the results of their projects would generate benefits for health (nearly 40% of benefits point in this direction).

The failure of some PI's to return the questionnaire in the internal phase of the evaluation meant that 20% of the projects funded could not be evaluated. Nevertheless, our final number of cases and rate of response were similar to or even higher than other reported experiences of ex-post evaluations. Kwan's study evaluating 205 projects reports a 87% response rate (Kwan et al., 2007) and Caddell's study evaluating 64 small-scale projects reports a 61% response rate (Caddell, Hatchette, & McGrath, 2010). Importantly, the budgets of the projects that were not evaluated were in the same range as those that were evaluated, which suggests that the size of the budget probably did not have a significant influence on whether the internal phase of the evaluation was successfully completed.

If the projects that were not included in this study were less likely to meet their objectives and/or to provide benefits, the results of this ex-post evaluation might be biased in a positive sense. Even if this were the case, evaluated and non-evaluated projects together would still for the most part have fulfilled their objectives considerably or totally (the 83% obtained in the sample studied could hypothetically drop to 66% when non-evaluated projects were included in the estimation), and would have provided either considerable or maximum benefits (the figure of 82% obtained in the sample studied could hypothetically drop to 65%). However, it must be pointed out that the underlying distribution that we should expect based on the ex-post evaluation literature (Rons et al., 2008) is right-skewed. This is indeed the distribution of our data when considering the overall qualitative assessment of each of the two components of the questionnaire, since more than 80% of the projects are clustered around the two highest scores.

It is reasonable to expect some of the findings in this study to be context specific. For example, results reported in Table 2 would probably be different in research areas of a more clinical and laboratory nature than in epidemiology and public health.

Table 1
Fulfillment of overall project objectives.

Objectives' fulfillment[a]	Projects	Mean[b]	SD	95% CI	Median	Minimum	Maximum
Totally	74	7.28	1.34	6.99–7.59	7.67	3.67	9.67
Considerably	69	5.78	1.31	5.47–6.09	6	2.34	8
Not very much	21	4.47	1.33	3.86–5.08	4.67	1.27	7.1
Not at all	9	3.21	2.53	1.27–5.15	3.5	0	6.34

SD = Standard deviation; CI = confidence interval.

[a] Evaluators ranked projects in these four categories according to their assessment of projects meeting their objectives.

[b] A numerical value (0–3) was assigned to each of the items related to objective fulfillment, and a total score was obtained for each project by summing these and transforming the result to a 0–10 scale. The mean value represents the average score attributed by all reviewers to each project in a given qualitative category.

Table 2
Payback to society reported by PIs.

Category of social payback	Benefit to society (the extent to which the project has contributed…)	*n* (%)	
Research capacity	To train new researchers	111 (15.3%)	360 (49.5%)
	To build new collaborative networks	94 (12.9%)	
	To develop new research objectives	129 (17.7%)	
	To improvements in infrastructure	26 (3.6%)	
Knowledge Translation	To set up companies and register patents	2 (0.3%)	81 (11.1%)
	To carry out clinical trials, demonstration projects, or interventional studies	8 (1.1%)	
	To the development of synthesis reports of scientific evidence, clinical practice or public health guidelines, or similar products	59 (8.1%)	
	As input to green papers, health plans, or similar	12 (1.7%)	
Potential healthcare benefits	To improve diagnosis	74 (10.2%)	286 (39.3%)
	To improve treatment	51 (7.0%)	
	To improve prevention	99 (13.6%)	
	To improve prognosis	62 (8.5%)	
Total		**727 (100%)**	

n = number of affirmative responses by PIs for each of the questions about payback to society, taking into account that each individual project could represent more than one benefit.

Our relatively unsuccessful attempt to create a questionnaire with acceptable internal consistency to adequately appraise projects' benefits is partially a consequence of the incipient nature of the literature on the subject and, consequently, the lack of comprehensible references to evaluate the questionnaire.

A final limitation of this study is related with the way PIs' report social payback of their own research. There is inevitably some degree of subjectivity when PIs attribute an impact level to their projects, which it might have biased results toward overestimation. However, despite the methodological differences, the results obtained in this study do not appear to differ greatly from those obtained in similar studies elsewhere (Caddell et al., 2010; Kwan et al., 2007).

Research funders and research organizations want both high quality scientific productivity and social payback, but most evaluation systems focus on the former instead of its impact on health (Smith, 2001). So, if the main aim of health research is to improve the health of people, a greater effort to measure projects social accountability should be made. Our intention in this paper is to contribute to the latter by providing a feasible methodology to assess the payback of small-scale research projects.

Conclusions

We report a tool for ex-post evaluation with good discriminating ability that makes it possible to measure the extent to which a project's objectives have been met (with satisfactory internal consistency) and the extent to which the project contributed benefits in terms of impact on the group's scientific performance and social payback. This allows for a better understanding of the impact of small-scale projects funded by a network center for research in epidemiology and public health and consequently, to inform decisions on future research strategies and investment. In this study, the investment would be rated as effective since 80% of funded research projects fulfilled their objectives and provided considerable benefits, and thus, showed a considerable return on investment.

In general, the purpose of institutional funding for small-scale projects is to provide initial or complementary support to enable researchers to better develop their research programs. The results of our study indicate that institutional funding provides not only this valuable support but also has an effect on knowledge translation, on clinical practice and on public health. These effects in turn share a great potential to benefit the health of the population.

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