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Preface

Ministries and agencies are being asked to describe and demonstrate their programmes and initiatives in an intuitive and coherent way. Policy makers, or, more general, people want programme managers to present a logical argument for how and why a programme is addressing a specific customer need.

A logic model, says Gretchen Jordan, Principal Member of the Technical Staff at Sandia National Laboratories, a U.S. Department of Energy (DOE) Laboratory, and the author of the key article of this newsletter, presents a plausible description of how the programme will work under certain conditions to solve identified problems. The logic model can be the basis for a convincing story of the programme's expected performance – telling stakeholders and others the problem the programme focuses on and how it is uniquely qualified to address it. The basic elements of the logic model are resources, activities, outputs and short, intermediate and longer term outcomes.

Platform fteval is interested in this method for several reasons: (i) logic models are an innovative communication tool to present the mission and the goals of an initiative and its architecture; (ii) logic models are an interesting method to plan a new initiative, particularly when it comes to formulate a coherent structure of goals and (iii) logic models are an 'unbeatable' starting point for ex post evaluations.

Beside the key topic on Logic Charts, this newsletter documents a workshop on impact measurement which Platform fteval organized together with the Austrian Council for Research and Technology Development.

Martin Falk's paper investigates the relationship between initial R&D intensity and firm growth using a unique data set for firms with R&D activities in Austria between 1995 and 2006. Results show that the initial R&D intensity has a positive and significant impact on both employment and turnover growth in the subsequent two years. However, the author finds that the impact of R&D intensity decreases significantly over time. All in all, Falk makes a convincing case of using quantitative methods in RTDI evaluation.

Richard Hummelbrunner and colleagues present a process monitoring system of impacts and demonstrate this system by means of an evaluation of the EU structural fund programmes. Their approach is interesting as it is a variation of the logic chart concept presented by Gretchen Jordan. Both articles demonstrate how methodologically heterogenic impact assessment can be.

Finally, Elke Dall, Dietmar Lampert, and Klaus Schuch show how methods of social network analysis can allow to measure the dynamics within RTDI project networks and to assess their development over time. The evaluation design presented in this short paper allows drawing evidence-based conclusions on the management of the *network* and *innovation projects*, the development of customer-vendor relations, the development of science-industry relations, the development of internationalization processes, and the sustainability of publicly co-funded innovation networks. In this context, however, only the results in terms of development of science-industry relations and development of internationalization processes are highlighted.

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Gretchen Jordan

Logic Models – a Method for Programme Planning and Evaluation: Applications to Research, Technology Development and Deployment Policies and Programmes

Abstract

Research and technology programmes world-wide are under pressure to demonstrate the value of their programmes. That and a desire to manage well both require a good understanding of what the programme intends to achieve and how, and how performance will be measured, evaluated and reported. The logic model is a planning, evaluation and communication tool that helps achieve these goals. This paper describes the logic model for a portfolio of research, technology development, demonstration, and deployment programmes or activities that have been developed by the U.S. Department of Energy and examples of key performance indicators and evaluation questions based on that model.

Introduction

Research and technology programmes world-wide are under pressure to demonstrate the value of their programmes. The challenges of demonstrating value require a clear programme design and delivery strategy, that is, a good understanding of what the programme intends to achieve, how it will be achieved, and how performance will be measured, evaluated, and reported. The logic model is a planning, evaluation and communication tool that helps in these endeavors. This paper describes the logic model using a generic model for a portfolio of research, technology development, demonstration, and deployment (RDD&D) strategies that has been developed by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE). The paper then describes how the logic model can be used in developing logically linked indicators and areas for evaluation.

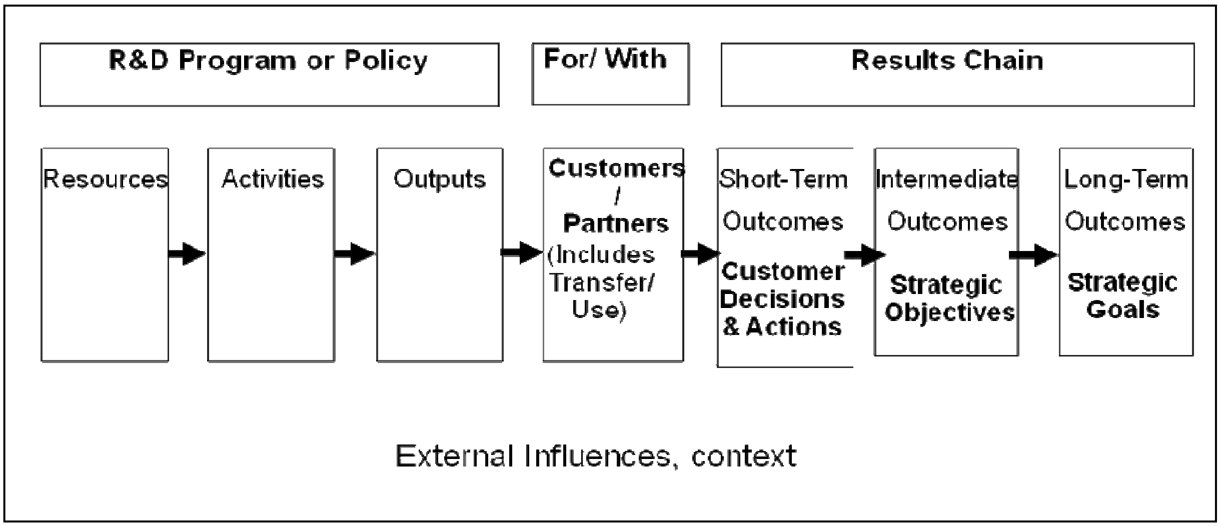
Logic Model Approach

Logic modeling is a thought process programme evaluators have found useful for at least forty years, and that has become increasingly popular with programme managers during the last decade. A logic model presents a plausible description of how the programme will work under certain conditions to solve identified problems. The logic model can be the basis for a convincing story of the programme's expected performance – telling stakeholders and others the problem the programme focuses on and how it is uniquely qualified to address it. The basic elements of the logic model are resources, activities, outputs and short, intermediate and longer term outcomes. Some have added the customers reached to the model, as well as the relevant external contextual influences present before a programme begins or appearing as the programme is implemented that can affect performance

(McLaughlin and Jordan, 1999, 2004).

While logic models may take many different forms, including narrative and table form, a common version is shown in Figure 1.

Figure 1. A Basic Logic Model Shows Causal Linkages Between Inputs and Results



The process of developing a logic model, if done in collaboration with programme managers and staff, brings people together to build a shared understanding of the programme and programme performance. The logic model also helps communicate the programme to stakeholders and other people outside the programme in a concise and compelling way.

The Logic Model is constructed in five stages described briefly here. For more detail see McLaughlin and Jordan, 1999 or 2004 or the University of Wisconsin Extension web site.

Stage 1. Collecting the Relevant Information. Collect from multiple sources including programme documentation, interviews with key stakeholders both internal and external to the programme, and a literature review.

Stage 2. Clearly defining the problem and its context. Start by clarifying the desired outcomes. Define aspects of "success" and then examine factors the programme will contribute to that. Follow this with "reverse" logic, what factors will prevent success (Funnell, 2000). These factors can be added to the programme design, or stay as acknowledged external forces that could influence programme success.

Stage 3. Defining the Elements of the Logic Model. Categorize the information collected into "bins" of the elements in Figure 1, or columns in a table. Summarize like things into "key" groups. Check to confirm that reading from left to right, there is an obvious sequence or bridge from one column to the next. One way is to ask "How did we get here?" or looking the other direction, "Why are we aiming for that outcome?"

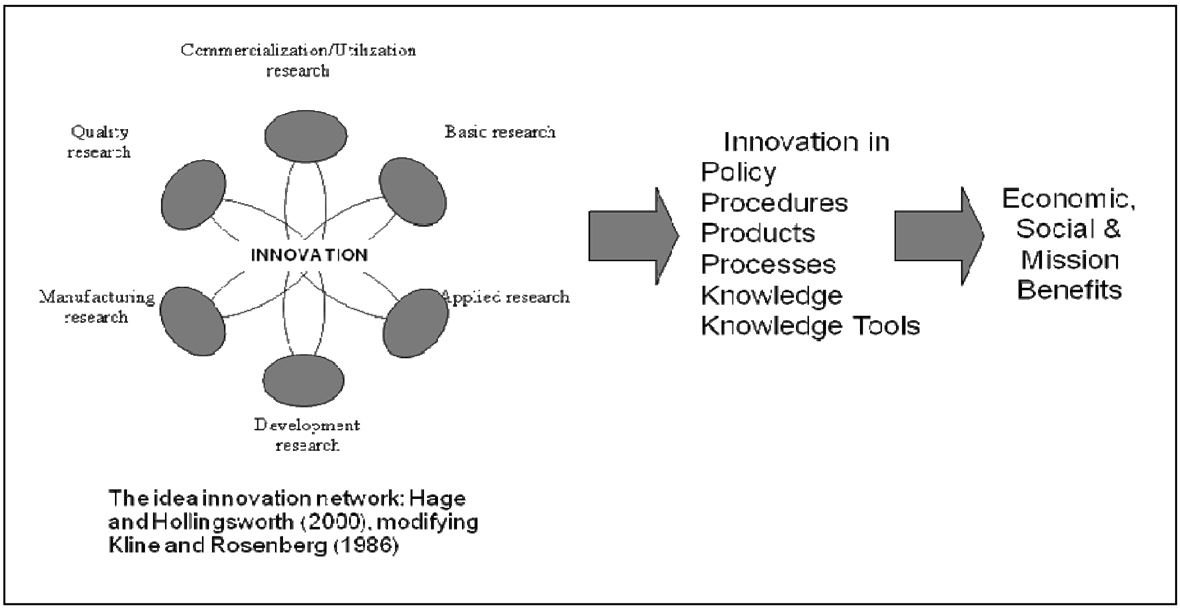
Stage 4. Drawing the Logic Model. The Logic Model is usually set forth as a diagram with columns and rows, with the abbreviated text put in a box and linkages shown with connecting one-way arrows. Although the example shows one-to-one relationships among programme elements, this is not always the case. It may be that one output leads to one or more different outcomes. Most programmes are complex enough that Logic Models at more than one level of detail are helpful.

Stage 5. Verifying the Logic Model with Stakeholders. The verification process followed with the table of programme logic elements is best continued with appropriate stakeholders engaged in a review process. Use the Logic Model diagram(s) and the supporting table and text. During this time, the work group also can address what critical information they need about performance, setting the stage for a measurement plan.

The Many Possible Logics of R&D Programmes

There are many possible logics for R&D programmes, as shown in Figure 2, because there are many possible combinations of (1) multiple arenas of research & technology development (R&D), (2) multiple kinds of innovations, and (3) a variety of possible intermediate & ultimate outcomes. The arenas of R&D are shown connected in non-linear fashion in the "Idea innovation network" (see Hage et. al., 2007). Innovation can occur in terms of new products or processes, but also in policies or procedures and business models, or in the new knowledge or knowledge tools of science. In constructing an R&D logic model, it may help to keep this big picture in mind.

Figure 2. Many Possible Combinations of R&D Arenas, Types of Innovation, and Outcomes



The Logic of EERE Programmes

The specific logic model example shown here in Figure 3 is for the U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE). The following is a description of the problem being addressed by EERE, and the strategies being used to help solve the problem.

> There are major security, economic and environmental challenges related to the production, distribution, and use of energy worldwide. In particular, U.S. taxpayers face problems such as dependence on foreign oil, disruptions in energy supply, air pollution, and the threat of climate change from burning of fossil fuels. Factors that might be addressed to mitigate these problems include the lack of competitively priced clean energy technologies; the limited knowledge, risk aversion, and budget constraints of consumers; and the externalities associated with public goods. To meet these challenges, the EERE programme focuses on factors related to developing clean energy technologies and changing customer values and knowledge about energy efficiency technologies and practices. In this way, the programme will influence both the supply of clean energy technologies and customer use of technologies that will lead to decreased use of energy, particularly of fossil fuels, and to increased market share for renewable energy sources.

Factors of the problem to be addressed by EERE and others are described as barriers. Both technology and market barriers hinder the ability of EERE to achieve its goals. These barriers have to be addressed in the design of programmes. Any that are not addressed by the programme remain as impediments to programme success that are external to the programme. Technology barriers are those that prohibit a potential technology from performing a desired function. Market barriers are those that inhibit the adoption and diffusion of a technology throughout the market.

The logic model for the EERE programmes (Figure 3) describes the goals and strategies and stages of RDD&D and the theory of change for each of these stages. The model indicates that the EERE programme is working in areas of technology supply, business and policy infrastructure, and demand. The general flow of the model is from top to bottom (inputs to outcomes) and from left to right (programme planning and assessment to deployment), with the end result in the lower right-hand corner (economic, security, and environmental benefits).

EERE engages in a wide range of programmes and activities, grouped into the seven areas, that yield a variety of outputs and outcomes. Given space limitations, we provide only a description of outcomes for each area.

The outcome of programme planning and assessment is that the programme makes appropriate strategic choices, and is funded in the areas targeted to meet programme goals and objectives (be these high risk/high pay off R&D or bringing lower energy bills to those with low household incomes), is operationally efficient, and exhibits fiscal responsibility. An outcome of good management is also stakeholder support and continued or increasing funds for the EERE programme activities.

The outcome of developing and maintaining programme infrastructure is that there is the required base of relevant scientific and technical knowledge, expertise, capabilities, and facilities to effectively deliver EERE programmes, and add to national capabilities more generally. These capabilities and those technologies not transferred to industry as yet, are available as options should circumstances change, for example a drastic increase in the price of electricity for whatever reason.

The outcome of basic or applied research is concepts and designs with possible commercial applications as well as knowledge that perhaps spill over into other research areas. This also contributes, along with developing and maintaining programme infrastructure, to national R&D capabilities, including options if circumstances change.

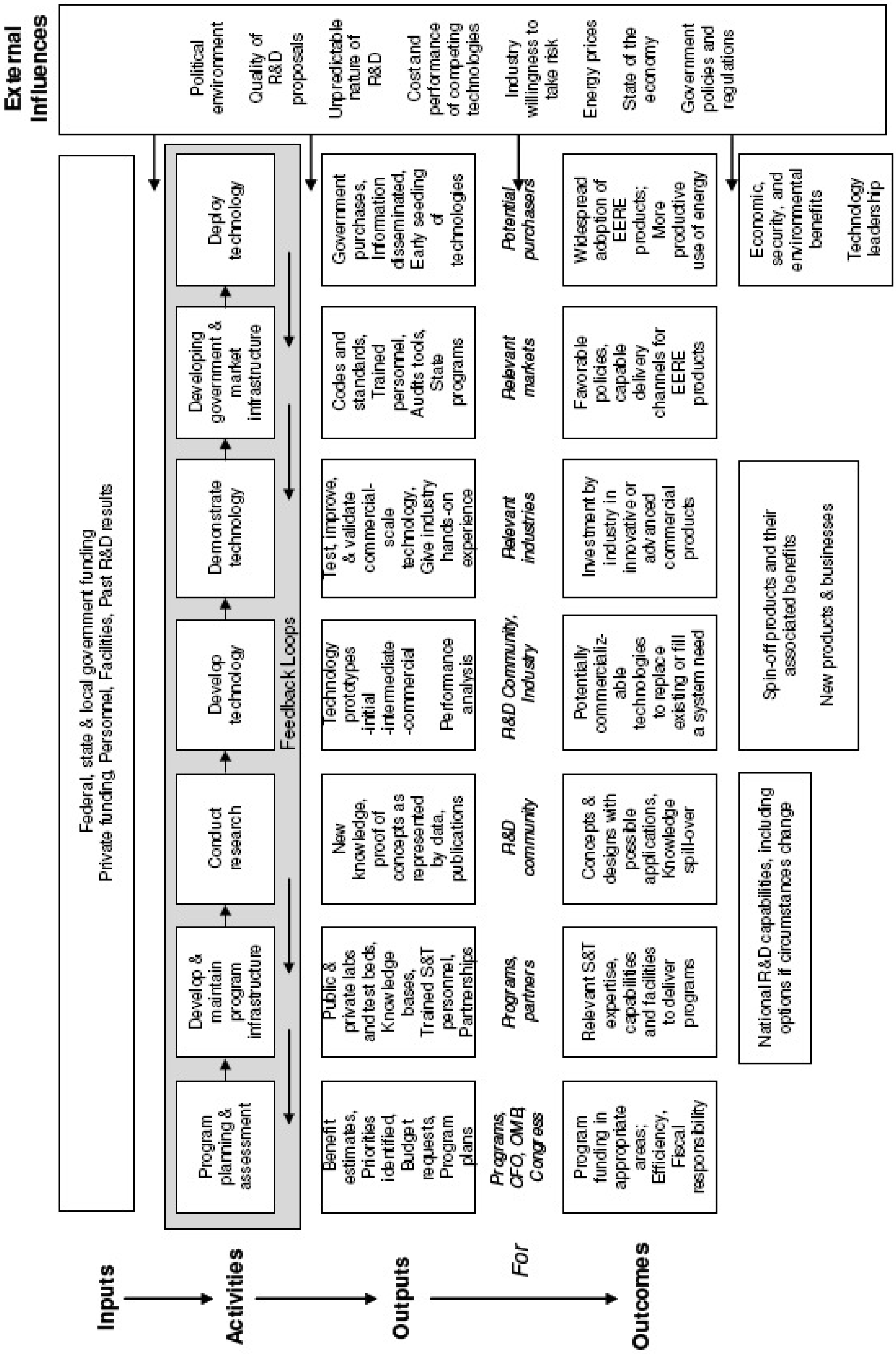
The outcome of technology development is that potentially commercialisable technologies are developed and available to replace existing technologies or to fill a system need (such as technology to connect energy from renewable sources to the electric grid). By available we mean a few have been made. These technologies are handed off to industry for manufacturing R&D and further testing and development, though there may be further assistance with demonstration tests and deployment. In addition to outcomes where EERE played a direct role, there are often technology spin-offs, and these also create new products, businesses and associated unforeseen benefits.

The outcome of tests and demonstration is that the technology is improved and validated and industry has had hands on experience with the technology and is now willing to invest in an innovative or advanced commercial product with improved cost and/or performance. This may also lead to technology spinoffs and their associated benefits.

The outcomes of developing government and market infrastructures are favorable policies and effective delivery channels for EERE products and practices. The favorable policies make financing for new technologies more available, encourage the consideration of life cycle costs and purchase of energy efficient, load management, or renewable energy technologies. Delivery channels mean businesses know enough to stock, sell, install and maintain these new technologies and are able to do so and operate at a profit.

Finally, the outcome of deployment activities is an increased awareness and appreciation by clients and consumers of the value of new and improved technologies and good energy conservation and management practices. This leads to permanent changes in behavior and purchasing, and the widespread adoption of EERE products and a more productive use of energy. If programmes are successful, all of these outcomes taken together will result in EERE achieving its intended goals for economic, security, and environmental benefits through EERE technology leadership.

Figure 3. High Level Energy Research, Technology Development, Demonstration & Deployment Logic Model



Identifying Programme Performance Indicators and Evaluation Questions

A good logic model captures the essence of the programme in a concise fashion, and includes the complete performance spectrum from inputs to outcomes. For those reasons, once the logic model is completed, it can help identify a set of "key" indicators for measuring and reporting whether a programme is on track to achieve its goals. Choosing a set of indicators based upon a logic model has several benefits:

- Keeps attention on all aspects of performance, perhaps at different levels of the organization. That also balances the perturbations that measurement puts in the system.
- Informs the timing of periodic in depth evaluations. There is no reason to look for outcomes if resources haven't arrived or steps along the way haven't happened.
- Attribution of outcomes to the programme is partially demonstrated by showing the related programmes activities and outputs.
- Helps choose effectiveness criteria that recognize views of multiple stakeholders.

Each box in the logic model represents a potential measurement area. Some indicators (e.g., energy expenditure savings) may be aggregated and are therefore applicable to multiple organizational levels – the EERE level, the programme level, and the project or technology level. Other indicators (e.g., technology cost and performance) are not able to be aggregated and are thus applicable to the technology level only.

While the boxes in a logic model help identify indicators, the arrows between the boxes help identify evaluation questions. These questions may be asked for two primary purposes, first to be accountable to the public for wisely spending public funds and achieving results, and secondly, to have information for programme managers to improve programmes. Evaluations may concentrate on relationships between activities or between activities and outputs. Or evaluations may look at whom and where to target efforts, who is receiving the benefits and who the programmes can partner with to achieve goals.

Another whole set of evaluation questions are those relating to programme impact and attribution of that impact to the programme activities. Did programme activities cause the desired outputs and outcomes? For example, based on the EERE logic model, the following questions may be appropriate for in-depth assessment of programme impact:

- Has research conducted by EERE yielded energy-related concepts and designs in priority areas with possible commercial applications?
- Have EERE efforts to develop government and business infrastructures led to favorable policies and effective delivery channels for EERE products and practices?
- Has the EERE portfolio of RDD& D programmes led to the adoption of EERE products and practices and yielded economic, security, and environmental benefits that would not have occurred otherwise?

Summary

Successfully managing a research and technology programme requires a good understanding of what the programme intends to achieve, how the programme will achieve it, and how the programme will be measured and evaluated. We have demonstrated with the U.S. Department of Energy example that the logic model tool helps in these endeavors by mapping out the linkages among programme inputs, activities, outputs and outcomes. We have attempted to make the RDD& D programme theory, the relationship between programme actions and results, explicit. We have tested that logic or theory by using it to confirm existing key performance indicators and evaluation questions and define new ones. This generic logic model can be used in part or whole as a template for specific RDD&D programmes.

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Martin Falk

R&D intensity and firm growth: Evidence from Austria for 1995-2006

Abstract

This paper investigates the relationship between initial R&D intensity and firm growth using a unique data set for firms with R&D activities in Austria between 1995 and 2006. Results based on the LAD estimator show that the initial R&D intensity has a positive and significant impact on both employment and turnover growth in the subsequent two years. However, we find that the impact of R&D intensity decreases significantly over time.

JEL: O 32, O 38, L25

Keywords: R&D activities, firm growth

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Introduction

The impact of R&D activities on firm performance has been of considerable interest to scholars, for a long time. The literature largely agrees that firm performance of R&D doing firms is better than that of non-R&D doing firms, and that the initial R&D intensity is significantly positively related to firm performance in the future period. Studies include Foray, Hall and Mairesse (2007) for large publicly listed U.S firms; Hall (1987) for U.S. industrial firms; Del Monte and Papagni (2003) for Italy; Nurmi (2004) for Finland; Yang and Huang (2005) for Taiwan and Yasuda (2005) for Japan. In recent years, quantile estimators are increasingly used to study the impact of R&D activities on firm growth (see Falk, 2009, Hölzl, 2009, Coad and Rao, 2008).

Austria is an interesting country case since it is one of the few industrialized countries that experienced a rapid increase in R&D expenditures in the last 15 years. Indeed, R&D intensity in the business sector (measured as the ratio of R&D expenditures in the business sector to GDP) doubled since the beginning of the 1990s (from 0.9 per cent in 1993 to 1.7 per cent in 2009). Given the increase in R&D expenditures in the last 15 years, it is natural to ask whether the magnitude of the impact of R&D activities on firm growth has changed over time. Given this background, it is surprising that there has been little reliable economic research at the firm level for Austria, given the large academic and public interest on this topic.

The aim of this paper is to re-examine the relationship between initial R&D intensity and employment growth in subsequent years. In particular, the stability of the parameter over time will be investigated.

It may be possible that the impact of R&D intensity of firm growth is rising or falling over time. The dependent variable is the average employment growth rate calculated for several two-year periods, over the period 1996-2006. Another aim of the paper is to check the robustness of the results with respect to different lags for the R&D intensity and different functional forms (log-linear or semi-log linear specification for the R&D intensity). To answer these research questions this study draws on a unique database of R&D doing firms provided by the Austrian Research Promotion Agency (FFG). With an estimation sample between 600 and 800 observations for each cross-section (excluding universities and public research institutions), it is a representative source of data for firms with R&D activities in Austria. The relationship between R&D activities and company growth is estimated using the OLS and median regression method. This study will lead to a better understanding of the importance of R&D to firm growth in one of the EU countries with a high level of R&D spending in the business sector relative to GDP.

In summarizing the literature four points can be noted from the literature. Firstly, very few studies seem to have included the very small firms with less than 10 employees. However, small businesses often have a high R&D intensity and should be included in the estimation sample. Secondly, service firms are not included in most of the cases. Thirdly, no study is available that investigates whether the impact of R&D activities on firm growth is constant over time in a country with strongly rising R&D expenditures. This is particularly important for Austria, since R&D expenditures increased considerably during the last 15 years. Fifthly, possible lag effects of the R&D intensity are insufficiently addressed in most studies at the firm level.

The structure of the paper is as follows; In section 2, we present the empirical model and the hypotheses; while in section 3, we present some summary statistics; in section 4, the empirical results for the impact of R&D on firm growth is presented; and in section 5, we make some concluding remarks.

Empirical model and hypothesis

Investment in R&D normally generates new products, processes and techniques that help a firm to achieve a competitive advantage in the market and thereby increase firm growth and market shares. In order to investigate the average effect of R&D one model firm growth as a function of size and age and a measure of R&D activity (Evans, 1987a, 1987b; Hall, 1987):

$$gr_{it} = \alpha_0 + \alpha_1 \ln L_{it-2} + \alpha_2 (RD_{it-\tau} / Y_{it-\tau}) + \alpha_3 dyoung_{it-2} + u_{it} \,,$$

where i and t are indexes of the firm and the year, with τ 2, 3 and 4. The growth rate is calculated as the geometric growth rate over a two year period: $gr_{it} = (L_{it} / L_{it-2})^{1/(t-(t-2))} - 1$. L is employment and R&D/Y is the ratio of R&D expenditures to turnover. Alternatively we employ the ratio of R&D employment to total employment. The company's growth not only depends on R&D spending but also on other factors. Jovanovic (1982) presents a theoretical model of firm growth and finds that firm growth depends negatively on firm age given its size. In order to measure age effects, we include a dummy variable for young firms, $dyoung$, that equals 1 if the firm has been founded between t-2 and t-5. Since R&D intensity is highly skewed, one can employ log R&D intensity. It is well documented that R&D activities will affect firm performance only with a long and uncertain time lag. Therefore, we also consider a one (t-3) and two-year time lag (t-4) for the impact of R&D intensity on firm growth besides initial R&D intensity (t-2). The growth equation can be estimated by OLS. Note that a selection bias may arise from using the sample of R&D doing firms. However, since nothing is known about non-R&D doing firms techniques to correct for sample selection bias cannot be used. The main hypothesis is that R&D intensity has a positive and significant impact on firm growth.

In the empirical section of the paper we investigate the following research questions: (i) What is the impact of the initial R&D intensity on the change in turnover and/or employment in subsequent years at the firm level, controlling for age and initial size? (ii) Is the relationship between R&D activities and firm growth stable over time or is there evidence of a rising or falling impact of R&D? (iii) What is the impact of firm age and size on firm growth of R&D-doing firms?

Data and descriptive results

The data used in this study is based on a unique data set containing firms with R&D activities applying for R&D grants from the Austrian Industrial Research Promotion Fund (FFG). The FFG is one of Austria's most important sources of finance for R&D projects carried out by business enterprises. Firms applying for an R&D project are requested to give information on (i) total turnover (in thousand €), (ii) the share of exports in turnover, (iii) the number of employees (full-time equivalents), (iv) the number of R&D employees (full-time equivalents), (v) expenses for research and development (in thousand €) and (vi) cash flow (in thousands €). In addition, there is information on the legal form and information on the geographic location of the firm.[1] These data have to be provided for the last three years of the year of application for a R&D project. The database includes all firms with at least one employee. The sample size ranges between 620 and 830 for each two-year period. It can be considered as approximately representative of all firms doing R&D given the number of 2 190 R&D doing firms in Austria in the private sector (NACE 10-72 and 74) for the year 2006 according to Statistics Austria.

The database is one of the most detailed in terms of coverage and data quality among most studies conducted so far. Each respondent has to provide complete and correct information on R&D expenditures and R&D employment. Data are more accurate than data from ordinal surveys. However, the database also has some limitations. For instance, there is no information on physical investment and industry affiliation.

Table 1 and Table 2 report the median of the key variables. The median employment growth rate for each two-year interval varies between 1.1 and 4.6 per cent per year. The median ratio of R&D expenditures is about 5 per cent (see Table 2). Table 2 also shows that firms are becoming more R&D intensive over time. This is consistent with the evolution of the aggregate R&D intensity in the business sector based on the R&D survey provided by Statistics Austria.

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[1] Regional dummy variables are never significant and are therefore not included in the final specification.

Table 1: Descriptive statistics for employment and turnover (median) growth rates by time

	average growth rates of employment (median)	# of obs.
1995-1997	1.1	546
1996-1998	3.4	619
1997-1999	3.5	633
1998-2000	4.6	698
1999-2001	4.2	727
2000-2002	3.2	704
2001-2003	2.5	737
2002-2004	2.3	830
2003-2005	3.5	853
2004-2006	4.0	822

Source: FFG, own calculations.

Table 2: Descriptive statistics for the two measures of R&D intensity and initial employment and the percentage of newly founded firms

	initial employment (median)	percentage of young firms founded in the last three years	ratio of R&D employment to total employment (median)	ratio of R&D expenditures to turnover (median)
1995	70	18	7.8	4.0
1996	67	17	7.9	4.1
1997	64	16	8.3	4.2
1998	57	18	8.3	4.0
1999	55	20	8.2	4.5
2000	54	22	8.0	4.7
2001	48	23	9.1	5.0
2002	49	23	9.3	5.0
2003	53	21	9.5	4.8
2004	49	18	10.5	5.2

Source: FFG, own calculations.

Table 3 presents the breakdown of firm growth by both R&D intensity and firm size. For each firm size class we observe that the median of the average employment growth rate increases with R&D intensity. For example, in the largest class (250 employees and more), the median employment growth rate ranges between 4.1 per cent for firms with a R&D intensity, between 10 and 20 per cent and -0.2 for firms with a R&D intensity of 1.5 per cent or less. Table 4 shows that the positive relationship between R&D intensity and the employment growth rate in the two subsequent years holds for both young and established firms.

Table 3: Median of the average employment growth rates in the next two years by initial firm size and initial R&D turnover ratio

	firm size measured by employment classes			
ratio of R&D expenditures to turnover:	1-9	10-49	50-249	>250
1.5% or less	8.0	4.1	1.7	-0.2
1.5% - under 4%	5.4	4.1	2.9	0.4
4% -under 10%	13.4	6.9	2.5	0.6
10% - under 20%	15.5	8.9	6.0	4.1
20% or more	18.3	8.2	5.0	n.a

Notes: See Table 3. Calculations are based on pooled data for the sub-periods 2004-2006, 2002-2004, 2000-2002, 1998-2000 and 1996-1998 with respect to employment growth, while R&D intensity is measured in the initial year.

Table 4: Average (median) employment growth rates in the subsequent two years by R&D intensity and by age between 1996 and 2006

	established firms	young firms
ratio of R&D expenditures to turnover:	3.4	10.7
1.5% or less	2.4	11.8
1.5% - under 4%	6.9	15.5
4% -under 10%	6.9	22.5
10% - under 20%	7.3	22.5

Notes: see Table 3. Source: FFG, own calculations.

Empirical results

Table 5 show the coefficients and the (bootstrap) t-values of the median regressions of the impact of R&D intensity on employment growth based on the pooled sample for the period 1996-2006. This table contains separate estimation results for five different periods, different lags of the R&D intensity (i.e. initial R&D intensity and two different lags), and two different functional forms for the R&D intensity (logarithmic and non-logarithmic form). Standard errors are based on the bootstrap method with 1000 replications. For the sake of comparison I also provide results using OLS (see Table 6 in appendix).

Table 5: Median estimates for the impact of the ratio of R&D expenditures to turnover on employment growth

R&D intensity measured in the initial year (t-2)

	no logarithm of R&D intensity: log employment (t-2)	**R&D intensity (t-2)**	newly founded (t-2,t-5)	cons.	with logarithm of R&D intensity: log employment (t-2)	**log R&D in-tensity (t-2)**	newly founded (t-2,t-5)	cons.	# of obs.
2004-2006	-0.012	0.021	0.067	0.090	-0.012	0.003	0.069	0.103	822
(t-2,t)	(-4.21)	(1.38)	(3.08)	(5.87)	(-4.20)	(1.37)	(3.15)	(5.38)	
2002-2004	-0.012	0.000	0.038	0.077	-0.011	0.003	0.037	0.083	830
(t-2,t)	(-3.32)	(0.06)	(2.46)	(4.06)	(-3.42)	(1.32)	(2.28)	(4.79)	
2000-2002	-0.021	-0.001	0.077	0.127	-0.019	0.012	0.067	0.160	704
(t-2,t)	(-5.33)	(-0.04)	(3.40)	(5.69)	(-5.15)	(2.83)	(3.31)	(6.46)	
1998-2000	-0.018	0.022	0.054	0.121	-0.014	0.015	0.067	0.164	698
(t-2,t)	(-5.10)	(0.59)	(2.02)	(6.44)	(-4.26)	(3.97)	(2.45)	(7.16)	
1996-1998	-0.025	-0.004	0.031	0.152	-0.019	0.014	0.013	0.17	619
(t-2,t)	(-5.41)	(-0.09)	(1.38)	(5.76)	(-5.15)	(4.06)	(0.54)	(8.21)	

R&D intensity measured lagged minus one (t-3)

	log employment (t-2)	**R&D intensity (t-3)**	newly founded (t-2,t-5)	cons.	log employment (t-2)	**log R&D in-tensity (t-3)**	newly founded (t-2,t-5)	cons.	# of obs.
2004-2006	-0.011	0.008	0.041	0.088	-0.011	0.006	0.043	0.110	580
(t-2,t)	(-3.42)	(0.45)	(1.25)	(5.05)	(-3.58)	(2.14)	(1.48)	(5.22)	
2002-2004	-0.014	-0.002	0.013	0.090	-0.010	0.004	0.014	0.085	561
(t-2,t)	(-3.40)	(-0.12)	(0.79)	(4.06)	(-2.62)	(1.56)	(0.82)	(4.03)	
2000-2002	-0.014	0.120	0.087	0.083	-0.016	0.013	0.084	0.149	483
(t-2,t)	(-3.24)	(3.56)	(3.85)	(3.35)	(-3.90)	(2.91)	(2.92)	(5.19)	
1998-2000	-0.016	0.084	0.033	0.120	-0.017	0.018	0.030	0.197	461
(t-2,t)	(-3.48)	(1.51)	(0.90)	(4.37)	(-3.86)	(4.23)	(0.91)	(6.57)	
1996-1998	-0.023	0.129	-0.017	0.145	-0.022	0.018	-0.012	0.213	397
(t-2,t)	(-4.38)	(1.67)	(-0.72)	(4.33)	(-5.03)	(3.89)	(-0.45)	(8.62)	

R&D intensity measured lagged minus two (t-4)

	log employment (t-2)	**R&D intensity (t-4)**	newly founded (t-2,t-5)	cons.	log employment (t-2)	**log R&D in-tensity (t-4)**	newly founded (t-2,t-5)	cons.	# of obs.
2004-2006	-0.013	0.006	0.035	0.103	-0.013	0.008	0.021	0.129	470
(t-2,t)	(-3.76)	(0.24)	(0.88)	(5.12)	(-3.67)	(2.33)	(0.63)	(5.59)	
2002-2004	-0.015	-0.001	0.028	0.095	-0.012	0.004	0.033	0.093	451
(t-2,t)	(-3.14)	(-0.05)	(1.19)	(3.68)	(-2.80)	(1.61)	(1.41)	(3.83)	
2000-2002	-0.014	-0.001	0.083	0.090	-0.013	0.007	0.082	0.113	396
(t-2,t)	(-3.17)	(-0.02)	(3.06)	(3.54)	(-2.94)	(1.63)	(3.09)	(3.66)	
1998-2000	-0.011	0.126	0.008	0.089	-0.013	0.013	0.028	0.157	367
(t-2,t)	(-2.11)	(2.02)	(0.20)	(2.96)	(-2.79)	(2.23)	(0.62)	(4.70)	

Notes: Dependent variable is the geometric annual change in employment over each two-year period. t-values in parenthesis are based on standard errors that are bootstrapped with 1000 replications.

The main result of the median regression model is that the (logarithmic) R&D intensity in the initial year has a significant impact ($p<0.05$) on employment growth in the subsequent two years in almost all cases. This means that the employment growth in the subsequent two years is higher when the firm's expenditures in R&D increase given total turnover. In particular, the results show that log R&D intensity is significant at the 5 per cent level in most of the cases (see Table 5). The corresponding coefficients range between 0.003 and 0.02.

While the results in terms of size and significance are similar with respect to the alternative measure of R&D intensity, there is apparent heterogeneity in the strength of the R&D intensity across time. For example, for the period 2002/2004 and 2004/2006, the R&D coefficient is much lower as compared to the periods 1996/1998, 1998/2000 and 2000/2000 (see Table 5).

Having found that the impact of R&D intensity on firm growth is decreasing over time, it is important to investigate the possible reasons for this. One reason is a change in the composition of the sample over time. As Table 1 indicates there is a decrease in the number of newly founded firms (founded in the last three years) from 23 per cent in 2001 to 18 per cent in 2006. To quantify this effect, we re-estimate the growth equation based on a balanced sample. Unreported results show that one can again find a decrease in the R&D coefficient over time, indicating that change in the coefficient is not due to a change in the composition of the sample. Another reason for the decline in the impact of R&D intensity on firm growth is the position of the business cycle. However, the periods 1998-2000 and 2004-2006 correspond to a roughly similar position in the business cycle.

The estimated coefficient on firm size is negative and statistically significant ($p<0.05$) in almost all specifications. This suggests that Gibrat's law does not hold for firms in our estimation sample.

Conclusions

The main objective of this paper was to re-examine the relationship between R&D intensity and firm growth and using a large and unique data set for Austrian firms for the period 1995-2006. Results of the least-absolute-deviation (LAD) estimator for the median-regression model show that the initial R&D intensity has a significant and positive impact on both employment and turnover growth in the two subsequent years. This finding is robust with respect to different lags of R&D intensity and different time periods. However, R&D investment is much more closely linked for the periods 1996-1998, and 1998-2000, as compared to the more recent time periods 2000-2002, 2002-2004, and 2004-2006, indicating that the impact of R&D decreases over time.

Explanations of the decrease in the impact of R&D intensity over time are hard to find. It would be interesting to repeat this study in other industrialized countries that also experienced a rapid increase in R&D intensity since the early 1990s such as China, Finland, Korea, Singapore, and Taiwan. The study is not free from limitations. One limitation is that investment and other determinants of firm growth are not included in the empirical model due to data availability. This study can be extended in a number of ways. One extension is the use of other performance measures such as the profit to turnover ratio.

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Appendix:

Table 6: OLS results of the impact of R&D intensity on firm performance

		no logarithmic specification					With logarithmic specification				
		impact of initial/lag R&D intensity on employment growth (t-2,t)									
		measure of R&D intensity: R&D expenditures in % of turnover									
		2004-2006	2002-2004	2000-2002	1998-2000	1996-1998	2004-2006	2002-2004	2000-2002	1998-2000	1996-1998
R&D turnover ratio (t-2)	coeff	0.010	-0.010	-0.002	0.012	-0.003	0.004	-0.003	0.015	0.023	0.019
	t	1.39	-1.27	-1.60	2.01	-0.59	0.79	-0.46	2.80	3.22	2.88
R&D turnover ratio (t-3)	coeff	0.007	-0.012	0.104	0.078	0.158	0.001	-0.001	0.023	0.020	0.026
	t	2.00	-1.10	5.52	1.96	2.74	0.19	-0.23	3.52	3.01	2.86
R&D turnover ratio (t-4)	coeff	0.011	-0.001	0.016	0.056		0.004	0.000	0.018	0.018	
	t	1.27	-1.57	1.07	1.21		0.65	0.05	2.50	2.13	
		measure of R&D intensity: R&D employment in % of total employment									
R&D employ. ratio (t-2)	coeff	0.075	0.056	0.107	0.107	0.086	0.004	0.004	0.019	0.030	0.022
	t	1.53	1.27	2.23	2.60	2.34	0.73	0.96	3.44	4.06	3.29
R&D employ. ratio (t-3)	coeff	0.014	0.087	0.055	0.122	0.072	0.005	0.010	0.012	0.027	0.021
	t	0.41	1.88	1.26	3.22	1.86	0.99	1.92	2.11	3.73	2.74
R&D employ. ratio (t-4)	coeff	-0.008	0.037	0.035	0.106		0.002	0.006	0.010	0.022	
	t	-0.20	0.95	0.96	2.78		0.41	1.15	1.73	2.71	
		impact of initial/lag R&D intensity on turnover growth (t-2,t)									
		measure of R&D intensity: R&D expenditures in % of turnover									
		2004-2006	2002-2004	2000-2002	1998-2000	1996-1998	2004-2006	2002-2004	2000-2002	1998-2000	1996-1998
R&D turnover ratio (t-2)	coeff	0.047	0.122	0.087	0.221	0.102	0.042	0.049	0.096	0.081	0.075
	t	2.06	3.59	5.62	9.67	5.37	3.28	3.72	4.40	3.66	3.67
R&D turnover ratio (t-3)	coeff	0.072	0.093	0.116	0.395	0.485	0.023	0.041	0.034	0.047	0.061
	t	5.12	2.46	2.23	2.84	2.90	2.40	3.02	3.68	3.18	2.84
R&D turnover ratio (t-4)	coeff	0.035	0.004	0.036	0.220		0.016	0.018	0.043	0.050	
	t	3.98	1.03	6.69	1.41		1.73	1.78	4.36	2.89	

		measure of R&D intensity: R&D employment in % of total employment									
R&D employ. ratio (t-2)	coeff	-0.083	0.181	0.418	0.287	0.171	-0.013	0.032	0.048	0.057	0.038
	t	-0.50	1.99	2.55	2.68	2.60	-0.65	2.14	3.41	3.79	3.47
R&D employ. ratio (t-3)	coeff	0.186	0.196	0.141	0.277	0.212	0.033	0.027	0.023	0.053	0.048
	t	1.64	2.38	1.64	3.37	2.59	1.79	2.30	2.37	3.82	3.74
R&D employ. ratio (t-4)	coeff	-0.016	0.272	0.055	0.232		0.002	0.023	0.020	0.054	
	t	-0.24	2.75	0.85	3.90		0.22	1.82	1.98	4.26	

Note: All equations include initial employment and a dummy variable for young firms. T-statistics are based on heteroscedasticity-consistent standard errors.

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Process Monitoring of Impacts – and its application in Structural Fund Programmes

Rationale for a different monitoring approach

Monitoring of Structural Fund- as well as other national or EU-programmes - has become a demanding task, which consumes substantial time and resources from monitoring staff who process data and produce reports, from programme authorities who assure data input, and from project owners who are requested to provide this data, mainly via reports. But the utility of these efforts is limited and increasingly being questioned: On one hand present Monitoring Systems are essentially input driven and focused on inputs and outputs. On the other hand they aim at monitoring programme implementation via quantified data and thus only contain a set of pre-defined indicators.

The problems and limits of present Monitoring Systems for Structural Fund Programmes are widely acknowledged by programme authorities and practitioners in the Member States, but also by the EU Commission. The current Structural Fund Regulations foresee a clear focus of Monitoring and Evaluation towards impact and strategic goals. And the corresponding "Working Paper on Indicators" recommends complementing present input-driven Monitoring Systems with a more impact-led approach and emphasizes result indicators as a core instrument for programme management.

However, the use of indicators has only limited value for capturing results and impacts, because the information on their achievement arrives rather late (i.e. after the finalization of programmes) and it is often difficult to provide evidence for the links between effects and programme activities. Moreover, impact achievement is a doubtful measure for the effectiveness of a programme, because it is due to many other factors and the influence of programme actors is relatively small. Thus, what programme actors can (and should) be made accountable for are not impacts, but the tasks they are responsible for in the implementation process - and on carrying out these tasks in a manner that effectively influences the behaviour of relevant actors in the desired directions.

But this would require a different approach to monitoring, which also looks at the processes that are expected to lead to results or impacts – and not just at indicators as their final measure.

Process Monitoring of Impacts

Brief description of the method

Process Monitoring of Impacts is an instrument for managing and steering interventions, with the aim to identify processes that are initiated by the programmes activities and are relevant for the achievement of results and impacts as well as to collect data or information required to observe these processes. It builds on the basic assumption that inputs as well as outputs have to be used by someone in order to produce desired effects. Thus focus is placed on those uses of inputs or outputs (by project owners, target groups, implementing partners, etc.), which are considered decisive for the achievement of effects and can be influenced by the operators of a programme.

Depending on the degree of use and the causal links with the project / programme under study, the actual (or expected) effects are classified as follows:

- *Outputs:* They are due to direct use of inputs by project owners, closely influenced by activities and implementation mechanisms of a project / programme.
- *Results (= immediate impacts):* Due to direct use of outputs, which is clearly linked with the project / programme and thus can also be directly influenced (although other factors can be important as well). A result should also be closely related to specific objectives of a project/programme (ideally the two should be identical).
- *Impacts:* Due to indirect use of outputs, which cannot be directly linked with the project / programme (attribution gap), but can at least be made plausible. Impacts normally relate to higher level objectives and are much more influenced by external factors.

The main challenge is to identify the likely connections between inputs, outputs, results and impacts and to check during implementation whether these links remain valid and actually take place. Thus the intended use of inputs and outputs constitutes the key linkage between the categories of effects.

The degree of use is also closely related to the time dimension: Outputs are by definition the first phenomena which can be observed as a consequence of programme / project inputs or activities, followed by results and impacts. And the use of inputs as well as outputs takes time, which must be taken into account when considering the level of effects to be addressed. This aspect is particularly important in the case of projects / programmes where outputs are predominantly produced at the very end of the implementation period. Although in these cases it is often not feasible to assess the achievement of results or impacts during the implementation period, it should at least be possible to outline the likeliness of the use of outputs.

Process Monitoring of Impacts consists of four main steps:

1. *Identify areas of effects* (results, impacts):

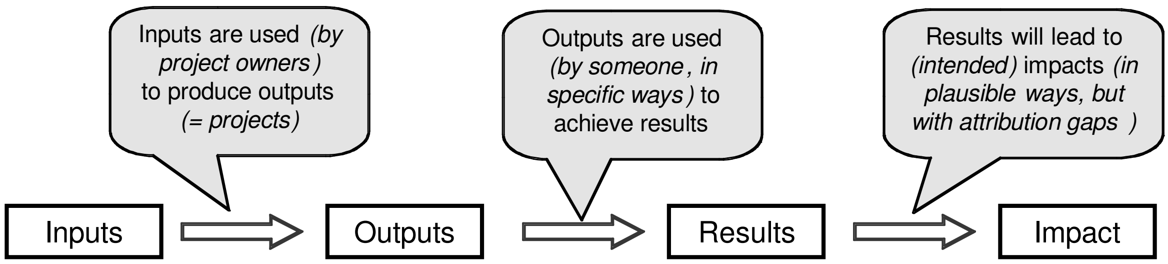
   Define effects and classify them in line with the definitions given above. Firstly by defining expected outputs, and secondly by deriving results and impacts from defined objectives. Furthermore, other probable effects could also be identified at this stage, e.g. based on prior knowledge or experience gained elsewhere, including negative effects, e.g. the potential “losers” of an intervention.

   In case of a larger number of intended effects, priority areas can be selected, which are considered crucial for successful implementation and where information from Process Monitoring of Impacts can be particularly useful (e.g. results which are particularly relevant, outputs whose actual use is crucial - or doubtful).

2. *Derive / agree on hypotheses for the achievement of effects*:

   Make assumptions about how inputs / outputs are used and by whom in order to produce intended effects. These assumptions can be based upon past experience, logical connections or professional knowledge. They should be described as processes (activities, behaviour or communication patterns of partners, target groups etc.) which constitute the links between the activities of a project / programme and intended results and impacts.

Fig. 1: Basic set of process assumptions



3. *Define areas of observation* to monitor these processes:

These hypotheses must be observed to test whether they actually take place during implementation. Important questions for this purpose are: who is expected to act or change? How much? Until when or during which period?

Observation might require the definition of milestones or indicators. Indicators can be quantitative or qualitative, but it must be borne in mind that they should be considered as product of preceding processes (and the related process assumptions).

4. *Data assembly and interpretation*: Process monitoring will most likely be a task distributed among several actors, thus responsibilities for the collection of data and information need to be defined. Procedures are influenced by the time requirements, available budget and work routines (can data collection be coupled with other activities already taking place?).

Care should also be taken to capture the entire range of effects (including those unintended or unexpected) which can be observed in a defined area And to regard deviations from intended routes not *a priori* as negative phenomena, but deal with them in a more differentiated manner. Because differences between plan and implementation as well as exceptions or unexpected effects are important sources of information for learning and improving implementation, as they can help to identify weaknesses, point at possible alternatives or lead to new solutions.

Important questions to be answered by data analysis: Are original assumptions about use of outputs still valid? What are specific problems or weaknesses in this respect? Should original assumptions or even intended results be modified? What can programme operators do to improve use of outputs? How can the behaviour of direct beneficiaries be influenced more effectively in the intended directions? What do unintended effects point at? What can be done to curb them?

Case example: Application with R&D support scheme in EU Structural Fund Programmes (ERDF)

In general terms, application in EU Structural Fund Programmes will be based on the hierarchy of effects foreseen in Programme Documents (outputs, results and impacts). The example below illustrates how the steps described in section 2.1 can be applied with a support scheme for R&D:

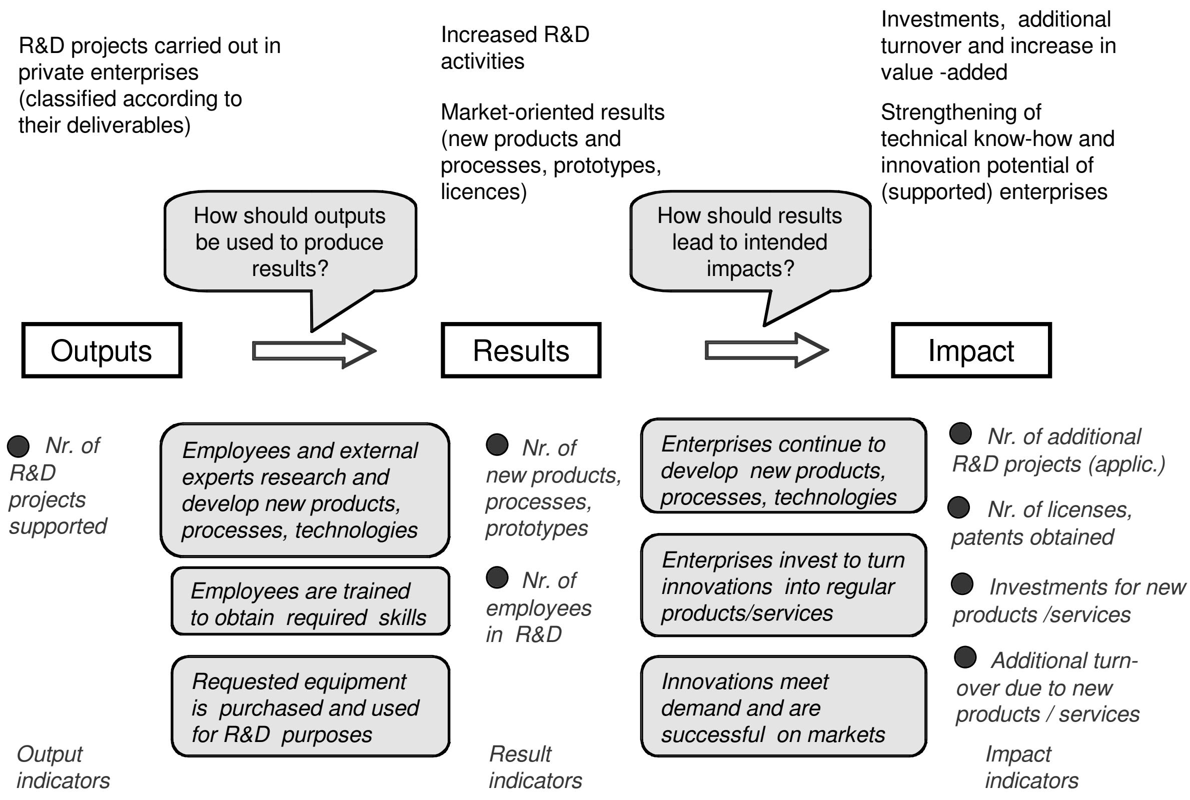
1. The objective of this scheme is to co-finance R&D projects by (private) enterprises, which should lead to market-oriented results (e.g. new products or processes, prototypes, licenses). The main effects are identified and classified in line with the definitions given above. Expected results (one of them is identical with the objective) can be directly linked with the use of outputs by project owners and target groups and their achievement can be influenced by the operators of the scheme. Impacts can only be linked in an indirect manner, their achievement depends mainly on supported enterprises and other actors (e.g. customers).

Fig. 2: Outputs, results and impacts of an R&D support schme

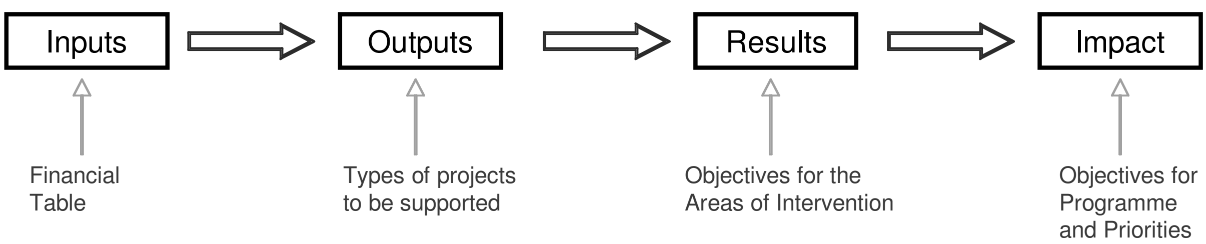
2. In order to link the various effects, assumptions are made about how - and by whom – they are used in order to produce one or more of the intended effects: The formulation of assumptions for achieving results should be directly linked to the use of outputs, whereas the assumptions for impacts can be formulated in a more open manner (see Fig. 3 below).

3. Indicators might be used to observe whether these assumptions actually take place, and sometimes it will be sufficient to collect data on these indicators. But if information on them arrives (too) late, the likeliness of achieving results/impacts – and the corresponding indicators – can be estimated by observing if and how the preceding process assumptions take place.

The Figure (Fig. 1) below summarizes the process assumptions and possible corresponding indicators:



When applying Process Monitoring of Impacts with entire programmes (or parts thereof), visualization becomes a challenging task. But use can be made of adapted versions of impact diagrams or logic charts. In the case of the current ERDF programme generation (funding period 2007 – 2013), the following conventions can be used to identify sources of information for the various effects:

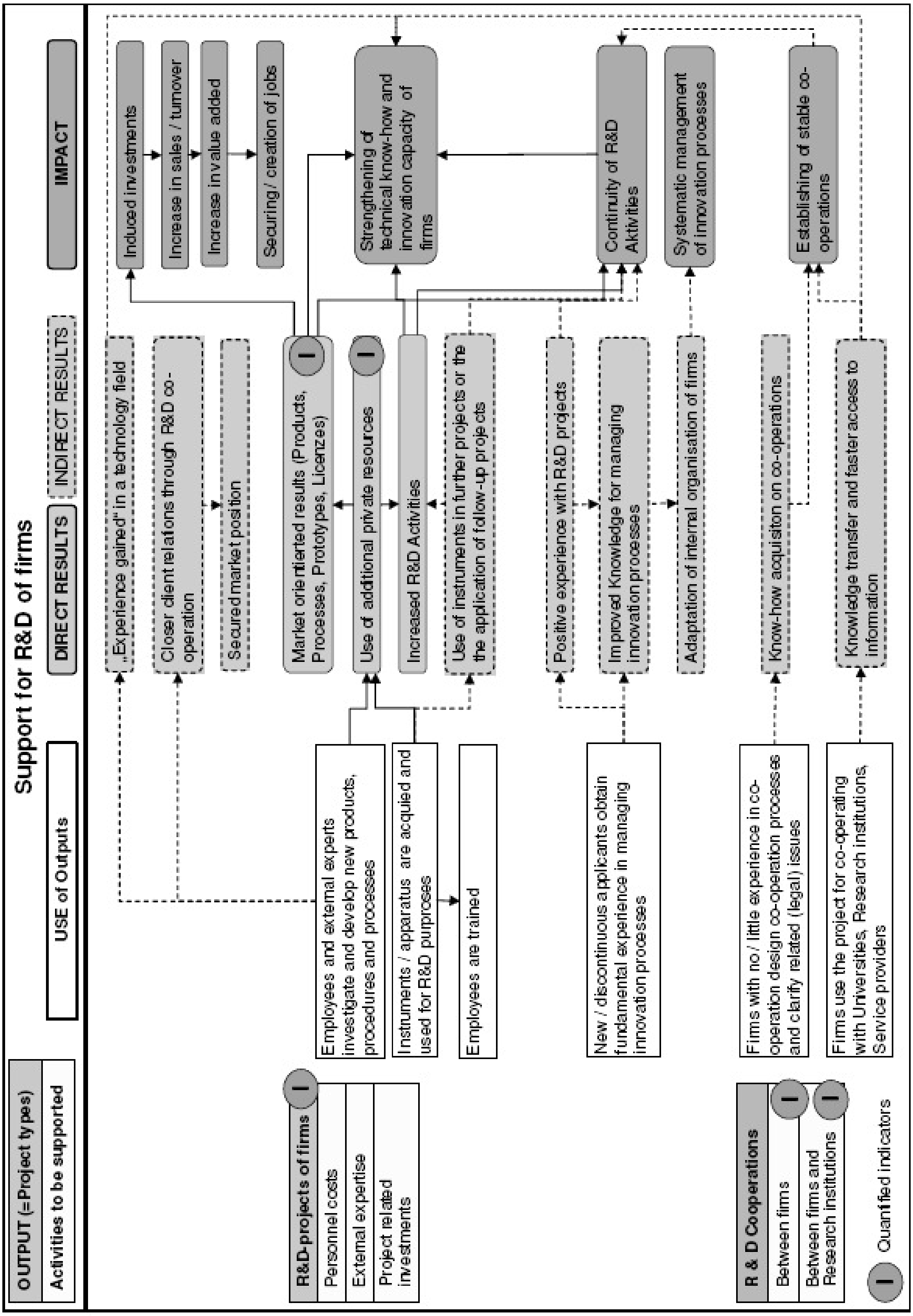


The Figure (Fig. 2) on the following page shows the impact diagram for the Area of Intervention "R&D activities of firms", included in the Styrian OP for the Objective "Regional Competitiveness" (and which is co-financed through the baseline programme of the Funding Agency FFG). The structure of the impact diagrams follows the time sequence of intended effects: Outputs are placed to the left, whereas and results and impacts are located on the right hand side of the diagram. A column which contains the main process assumptions (labelled “use of outputs”) is placed in between and illustrates the essential linkages between these effects.

In this case, explicit assumptions were only made for the use of outputs, and the plausible connections between expected results and impacts were merely indicated through arrows. The impact diagram was drawn up during the programming phase, in collaboration with the involved funding authorities and based on the descriptions contained in the draft OP.

This has helped to clarify the intervention logic – and as a consequence a range of “indirect results” were inserted in the diagram, which were not included in the OP but which were derived from other information sources (e.g. experience or implicit goals of the authorities, findings of evaluations). Last but not least, the indicators foreseen in the OP were inserted in the diagram – and this clearly shows which (small) parts of the intervention logic can actually be captured by quantitative indicators alone.

The diagram also served to identify a set of questions in order to observe whether the underlying process assumptions actually take place (see annex). Furthermore, in this case the questions were grouped so they can be integrated with the assessment and evaluation procedures of the Funding Agency FFG (project reports or final meetings with project owners, follow-up survey).


Support for R&D of firms
OUTPUT (=Project types)
Activities to be supported
USE of Outputs
DIRECT RESULTS
INDIRECT RESULTS
IMPACT
R&D-projects of firms
Personnel costs
External expertise
Project related investments
R & D Cooperations
Between firms
Between firms and Research institutions
Quantified indicators
Employees and external experts investigate and develop new products, procedures and processes
Instruments / apparatus are acquied and used for R&D purposes
Employees are trained
New / discontinuous applicants obtain fundamental experience in managing innovation processes
Firms with no / little experience in co-operation design co-operation processes and clarify related (legal) issues
Firms use the project for co-operating with Universities, Research institutions, Service providers
„Experience gained" in a technology field
Closer client relations through R&D co-operation
Secured market position
Market orientierted results (Products, Processes, Prototypes, Licenzes)
Use of additional private resources
Increased R&D Activities
Use of instruments in further projects or the the application of follow-up projects
Positive experience with R&D projects
Improved Knowledge for managing innovation processes
Adaptation of internal organisation of firms
Know-how acquiston on co-operations
Knowledge transfer and faster access to information
Induced investments
Increase in sales / turnover
Increase in value added
Securing / creation of jobs
Strengthening of technical know-how and innovation capacity of firms
Continuity of R&D Aktivities
Systematic management of innovation processes
Establishing of stable co-operations

Experience with applying "Process Monitoring of Impacts" in Austria (and beyond)

The approach was developed by ÖAR Regionalberatung in 2004 in the framework of a research contract from the Austrian Federal Chancellery (Dept. for Spatial Planning and Regional Policy) to identify viable alternatives for current ERDF-monitoring practice. It is a blend of two approaches, which have originally been conceived for international development aid (Impact - oriented Monitoring[2]: and „Outcome Mapping"[3]), adapted to the needs for monitoring programmes in structural policy. And it incorporates elements from other theory-based approaches to impact assessment (e.g. logic charts, contribution analysis).

Process Monitoring of Impacts was first tested in 2005 at project level (trans-national cooperation projects of INTERREG IIIB Programmes) and at programme level (impact analysis of selected measures of the Styrian Objective 2 programme). During 2006/2007 the approach was applied in the preparation of the Styrian OP for the Objective "Regional Competitiveness" and in the framework of several ex-ante evaluation assignments:

- Programmes for Objective Regional Competitiveness (Carinthia, Upper Austria)
- Cross-border Cooperation Programmes: Austria – Slovenia, Austria – Bavaria, Lake Constance (Austria / Germany / Switzerland / Liechtenstein)
- Trans-national Cooperation Programmes: Central Europe, South-East Europe

In ex-ante evaluations the approach (notably the impact diagrams) was used to clarify the intervention logic and to assess the likeliness of achieving expected results and impacts. This required to incorporated different values and interests of the involved various stakeholder groups. The experience gained with applications in European Territorial Cooperation (ETC) programmes were summarized in a study commissioned by the INTERACT Point Managing Transition and External Cooperation[4].

Process Monitoring of Impact" approach has also been applied in the framework of two ex-post evaluations, where it was used to assess the achievement of effects in a retrospective manner:

- Evaluation of the RIF 2000 programme, a national programme for the support of business-related infrastructure in Austrian regions (up-grading of impulse centres)
- Swiss participation in the INTERREG III Community Initiative (6 programmes).

Last but not least, the approach is currently being applied as part of the on-going evaluation of the OPs for the Objective "Regional Competitiveness" in Styria and Carinthia. The achievement of expected results will be assessed for selected Areas of Intervention, based on

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[2] This approach is essentially used in German Development Aid, notably by Bundesministerium für Zusammenarbeit (BMZ) and Gesellschaft für Technische Zusammenarbeit (GTZ)

[3] This approach has originally been developed in Canada by the International Development Research Centre (IDRC).

[4] R. Hummelbrunner: Process Monitoring of Impacts – Applied Study for the European Territorial Cooperation programmes, Vienna, October 2007

information available for already approved projects (applications, reports). Complementary telephone survey of project owners will be carried out to identify unintended effects. These cases will also be a test for using the approach with large quantities of data (several hundred of approved projects).

Lessons learned and Outlook

An important lesson learned from these applications was the utility of the impact diagrams. Provided that sound base-line information is available from OPs, impact diagrams can be elaborated rather swiftly. Since the use of a computer has proven to be very convenient, ppt. formats were generally used for elaborating impact diagrams. But of course, this can also be done by using other methods, e.g. METAPLAN technique (cards and pinboards).

They have proven to be an effective tool for clarifying or focusing a programme´s logic, to arrive at a joint understanding on expected effects and the ways to achieve them. In all cases the impact diagrams have helped to improve the descriptions of strategies / priorities or to clarify the types of outputs (= projects) to be funded by the programme. And they were successfully used for validating and improving indicator systems. The diagrams served to identify suitable indicators, to check the usefulness of proposed indicator systems or to highlight which of the intended programme effects do not lend themselves for being monitored via quantifiable indicators.

Yet, impact diagrams are not an end in itself, but the starting point for programme monitoring. Observing whether the process assumptions actually take place requires that corresponding information is collected via applications, reports or other contacts with project owners. However, until now the coherent integration of these aspects in the entire management cycle could only be outlined, since none of the involved programme authorities were (yet) willing to integrate the suggested amendments in their templates for Application Forms or Project Reports. Yet the main reason for this reluctance was not a lack of interest in the approach, but the already heavy burden with monitoring and financial control, which leaves little space for internal learning processes-or a more thorough performance management of programmes.

But as the cases cited above have demonstrated, Process Monitoring of Impact can not only used for monitoring programmes or projects during their implementation, but can be applied at different stages – and for different purposes:

- In ex-post applications Process Monitoring of Impacts can be used to reconstruct the underlying intervention logic and to assess whether expected results and impacts were achieved (or are achievable). Programmes often lack internal coherence of objectives and effects, thus structuring their hierarchy of objectives based on impact diagrams turned out to be helpful for attaining a clearer picture of the programme, which again allowed to identify internal interdependencies of effects resp. impact creating processes (e.g. in different areas of a programme).
- can also be applied during early stages in implementation, whereby the focus of attention is

placed on the likely use of inputs. By specifying and observing assumptions for their use, actors can identify already at very early stages whether the programme will likely lead to the desired outputs (= type and number of projects) and can take steps to improve the conditions for the use of inputs (e.g. promotional efforts, technical assistance for applicants, support for partner search, modification of procedures). This is particularly relevant in cases where outputs are mainly produced at the end of the implementation period, here only information on the use of inputs can provide information for steering the intervention in direction of desired outputs, whereas it is not yet possible to assess the use of outputs or the achievement of effects later on.

Compared to current monitoring practice in Structural Fund programmes, Process Monitoring of Impacts offers a range of advantages:

- It responds to the information needs of impact-led management, observes the achievement of objectives and produces information needed to understand impact creating processes.
- It allows identifying behaviour or interaction patterns which are crucial for achieving effects. Their observation can be carried out in collaborative forms and need not demand more time from programme implementers than current monitoring practice.
- Quantitative indicators can be used with this approach, but instead of regarding them as isolated phenomena they are considered products of preceding processes. Their interpretation is always based on relevant context information and the perspectives of different actors.
- Moreover, it is not necessary to wait until a chosen indicator is met for assessing the achievement of results. Instead, understanding and observing the underlying processes provide early indication whether a project / programme is on the right track – or risks to miss desired results.

In addition, there are several advantages for specific stakeholder groups:

Stakeholder groups	**Main advantages**
Programme actors	• Joint orientation for future project assessment and selection • Early information on likely achievement of results • Common learning as programme evolves
Project owners	• More flexibility during implementation (as monitoring focus is on processes for achieving results - and not on activity plans) • Simplified / standardised reporting and streamlined applications
Evaluators	• **Identification of evaluation questions** • **Analysis and processing of project level information**
All actors / stakeholders	• Joint focus on achieving intended results

As it orients the observation of programme authorities and other involved actors towards the achievement of objectives, Process Monitoring of Impacts can complement present input-driven

Monitoring Systems with an impact-led approach. This is in line with Commission proposals to shift the focus of attention in Structural Fund programmes towards the achievement of results and impacts.

It can lead to a clearer distinction of monitoring activities, which have different functions and meet different information needs of involved actors:

- The electronic Monitoring System will contain controllable and quantifiable data which is formally required by programme administrators at higher levels (Managing Authority, EU Commission) and for reporting to the political level or a wider public. The main consequence for Electronic Monitoring Systems could be streamlined contents, by focusing on those aspects where quantified data is meaningful and collection can be managed quite easily.
- Process Monitoring of Impacts will provide qualitative and quantitative information on the likely achievement of effects. This information is meant for programme actors and other professionals involved (e.g. evaluators). It will predominantly be produced via Application Forms and Project Reports and should facilitate joint learning of programme actors in order to improve implementation.

Process Monitoring of Impacts leads to the establishment of a comprehensive Management Information System, which combines existing elements and procedures in an interconnected manner: Electronic Monitoring Systems, Applications, Reports, Contacts / meetings with applicants, project assessment and evaluation. The innovation therefore lies not in the individual elements, but in their new and creative combination. Such a coherent framework for knowledge management can be supported by the work of evaluators; especially if evaluations are carried out in an on-going manner and are focused on joint reflection and learning.

Because Process Monitoring of Impacts does not assess the actual achievement of effects, but contributions towards desired changes, it is particularly suited for projects / programmes which act in an indirect way through partners. And because it is based on the observation of processes, it is well suited to monitor "soft" measures, which mainly produce intangible results that are difficult to capture via quantitative indicators.

Based on the experience gained so far, Process Monitoring of Impacts appears well suited to be applied with Structural Fund Programmes, incl. those addressing R&D-measures. It is very appropriate to address the challenges posed by the new Objective "Regional Competitiveness and Employment", since the content of these programmes mainly consists of "soft" measures and "open-ended" tasks. These often involve complex initiatives with intangible or long-term outcomes which are difficult to be covered by Monitoring Systems based solely on quantified indicators.

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Annex: Support for R&D in firms - Questions for (additional) contents based on impact-related assumptions (extract)

Project type	Reports / Final Meeting with project promoters	Follow-up Surveys
R&D projects of firms	– Has the R&D project led to a market oriented result? if yes: o New Product o New Service o New Process – Are investments planned for their introduction? – Are prototypes planned / have been realized? – Will patents / licences be applied for? Has this already been initiated / achieved? – Have employees been trained to work with instruments / apparatus acquired with financial support? If yes, how many? – Is it planned to use these instruments / apparatus in future R&D projects? – Is a follow-up R&D project foreseen as a result of the current project? Will public support be applied for? – Has the R&D project been carried out in collaboration with clients? Will this co-operation improve client relationships? – What is the number of R&D projects submitted by the firm for public support in the last 5 years? Additional questions with new / irregular applicants: – What were (positive / negative) experiences made with the R&D project? – Has the firm´s knowledge for managing innovation processes improved during the course of the R&D project? Did this lead to an adaptation of the firm´s internal organisation? – Are systematic improvements of innovation management intended? How / in which respect?	– How were the results of the R&D project implemented in economic terms? – Did the development of new products /services/ processes lead to investments? What was their volume? Has public support been applied for / has been granted?What was the increase in turnover obtained through sales of new products / processes? – Did the implementation of new products / processes lead to the creation / securing of jobs? How many? – If a market oriented result has not been obtained, has experience been gained in the respective technology field as a consequence of the supported R&D? Did this strengthen the technical know-how and innovation capacity of the firm? – Did the collaboration with clients during the R&D project actually improve client relationships, in which respect? – How many R&D projects have been carried out since the supported R&D project? For how many of them has public support been applied for / received? What was the volume of private resources invested in these R&D projects? – Have systematic improvements of the firm´s innovation management taken place? How / in which respect? – How many R&D projects have been carried out since the supported R&D project? For how many of them has public support been applied for / received? What was the volume of private resources invested in these R&D projects? – Were positive experiences made with these R&D projects as well?

Elke Dall, Dietmar Lampert, Klaus Schuch

Evaluating Publicly Co-funded RTDI Programmes – Preliminary Benchmarks and Conclusions

Abstract

The evaluation design presented in this short paper allows drawing evidence-based conclusions on the management of *network* and *innovation projects* implemented under the CIR-CE programme, the development of customer-vendor relations, the development of science-industry relations, the development of internationalisation processes, and the sustainability of publicly co-funded innovation networks. In this context, however, only the results in terms of development of science-industry relations and development of internationalisation processes are highlighted. A short outlook on the sustainability of the networks is provided too.

Introduction

The aim of this paper is to share conclusions drawn and insights gained from the evaluation of a cross-border RTDI programme (see *Evaluation Context* below). Therefore, the authors will provide a brief overview of the evaluation context as well as the chosen evaluation approach, proceed with the evaluation results, briefly discuss those, and finally present their conclusions.

Evaluation Context

The Programme

The programme *CIR-CE* (Cooperation in Innovation and Research with Central and Eastern Europe) provides the context of the evaluation. Its main goal is to promote transnational innovation networks between Austria and the partner countries in Eastern, Central, and Southeastern Europe. The two derived sub-goals[1] are the improvement of

(1) "[…] the innovative capabilities of companies (especially of SME[2]) and their ability to assimilate and implement external knowledge", and

(2) "[…] the cooperative capabilities of companies (especially of SME)", especially vis-avis-Central and Southern European partners, the "creation of sustainable cross-border innovation networks and cooperation structures".

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[1] cf. Austrian Research Promotion Agency 2005a, pp. 5

[2] small and medium-sized enterprise(s)

CIR-CE was developed and is being funded by the BMWFJ (Austrian Federal Ministry of Economy, Family, and Youth)[3] .The programme is being implemented by the Austrian Research Promotion Agency (FFG).

Goals of the Evaluation

The concept[4] for the monitoring and evaluation of the programme determines three levels: the policy level, the programme level, and the project level. The evaluation presented here takes place on the programme level. Its goals are thus in accordance with the programme goals, i.e. the establishment and expansion of transnational RTDI project networks. Therefore, the main objective of the evaluation is to analyse those networks, in particular their development over time, by employing methods of Social Network Analysis (SNA) methodology.

The task to evaluate CIR-CE was awarded to an external evaluator – the ZSI (Centre for Social Innovation).

Evaluation Approach

To analyse the RTDI networks, i.e. their development (establishment and expansion), and the extent to which the results meet the programme expectations, a longitudinal approach was chosen. A sample of projects was to be examined at several points in time throughout the project implementation: at the beginning of the projects (t_1), at mid-term (t_2), and at the end of the projects (t_3). In addition, the project networks were to be examined one year after their formal conclusion (t_4). At these points in time, data were to be gathered via online surveys.

All project partners are regarded as *actors* in our SNA (Social Network Analysis) model. The set of actors participating in each of the online surveys was defined and, although some projects foresaw an enlargement of their network, the number of actors was expected to become stable over time.

The actors' exchange relations were surveyed along different dimensions of both material and non-material exchange:

1. communication among actors on project management
2. communication among actors on project content
3. non-project related communication among actors
4. exchange of goods among actors
5. exchange of services among actors
6. exchange of information among actors
7. exchange of valuable new contacts among actors

and "trust" relations among the partners as an eighth dimension of a more emotional quality.

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[3] formerly BMWA (Austrian Federal Ministry of Economy and Labour)

[4] Austrian Research Promotion Agency 2006

The theoretical basis of CIR-CE and of the evaluation is the assumption that (1) innovation takes place through cooperation and that (2) cooperation can be approximated by changing communication patterns. The basic idea is that the ability of all partners to use the results of the project effectively to build capacities within their organisations depends – to a certain degree – on the *strength* of their participation in exchange relations. These exchange relations are approximated by the inclusion or exclusion of partners and the accessibility of each partner within the network structure. As structural dimensions of communication patterns, the design employed *communication intensities* and *communication densities*. Firstly, *communication intensities* are proxies to assess the subjectively perceived quality of exchange relations ('high', 'average', 'low', 'none'). The ratings represent the *strength* of ties (called directed edges or directed arcs in graph theory). Secondly, *communication density* assesses the exchange links between the partners ('absent' or 'realised'). Together, these two structural dimensions are indicators that characterise the complex network systems constituted by the individual projects, and the observed developments in the network dynamics over time.

The analysis focuses on the *intensity* of exchanges rather than on their frequency, as the intensity appears to reflect in a more general way the occurring relations within a RTDI project. The following three attributes have been recorded for all actors:

- role in the project: co-ordinator / partner
- location: country
- kind of institution: industrial enterprise/SME, university/research, intermediary institution

This allows the analysis of clusters (in the SNA sense) within a project network, in particular concerning science-industry relations, customer-vendor relations, and internationalisation.

The dimensions in focus for the analysis are considered valid and reliable measures. It has been taken into account that the reliability of aggregate measures is higher than the reliability of individual choices of actors[5]. Since the SNA was contractually connected to the reporting requirements of the selected projects, a very high response rate could be achieved.

As stated above, the conclusions are drawn from a sample of all projects applying for funding. To enhance the quality of the data, an informed choice by both the programme management and the evaluation team has been made, that took into account the number of project partners, the geographical area, the type of the project (*network project* or *innovation oriented project*), the number of countries involved, and available ex-ante evaluation results.

[5] Wassermann and Faust 1994, p.59

Results

Before going into the results, it needs to be noted for the purpose of their interpretation that the chosen approach included the definition of an 'optimal relation' (expressed in a distinct value) to assess the realised networks. These values have been taken as benchmarks to assess the achievements of the set programme objectives. A completely connected network (100 % density), i.e. each actor being engaged in exchanges with all other actors, is not necessarily the aim of a project and sometimes not even favourable (more about that below). Thus, certain critical factors on which the evaluation will be focussing must be and have been extracted.

Although the evaluation follows several specific evaluation criteria[6], this short paper focuses on two, namely science-industry relations and internationalisation. These two criteria are representative for the methods applied, can provide insights into benchmarking RTDI networks, and are the most interesting to present to this audience.

Science-industry relations

To assess the dynamics of science-industry exchange relations, the actors have been clustered into two groups, (1) the knowledge-"providers" and (2) the knowledge-"users". These groups represent the role of each actor in the network. On the science side are mainly "academia" and consultants, on the industry side are mainly SME. This clustering poses a simplification since each actor can potentially contribute to any knowledge exchange and "consume" knowledge provided by any other actor.

Since hardly any empirical evidence about the density development of science-industry relations is available, the following hypothesis has been assumed: *Due to requirement by the publicly funded RTDI programme, industry-oriented innovation networks show a strong tendency to engage in science-industry relations. Thus, the density of science-industry relations will affect a high share of network partners. It is assumed that, in order for a network to be regarded successful, at least 80 % of all possible exchange relations between network partners from the "science" side and the "industry" side in terms of (1) the exchange on project's intrinsic (technical) content and (2) other valuable information should be realised.*

As shown in the figure below, the communication of project content between the actors on the science side and the actors on the industry side developed favourably throughout the project implementation. Although projects starting with the highest degree of exchange (in particular proj_2[7]) had less to gain than the other projects, each project exceeds or comes within close reach of the predefined benchmark of 80 % network density.

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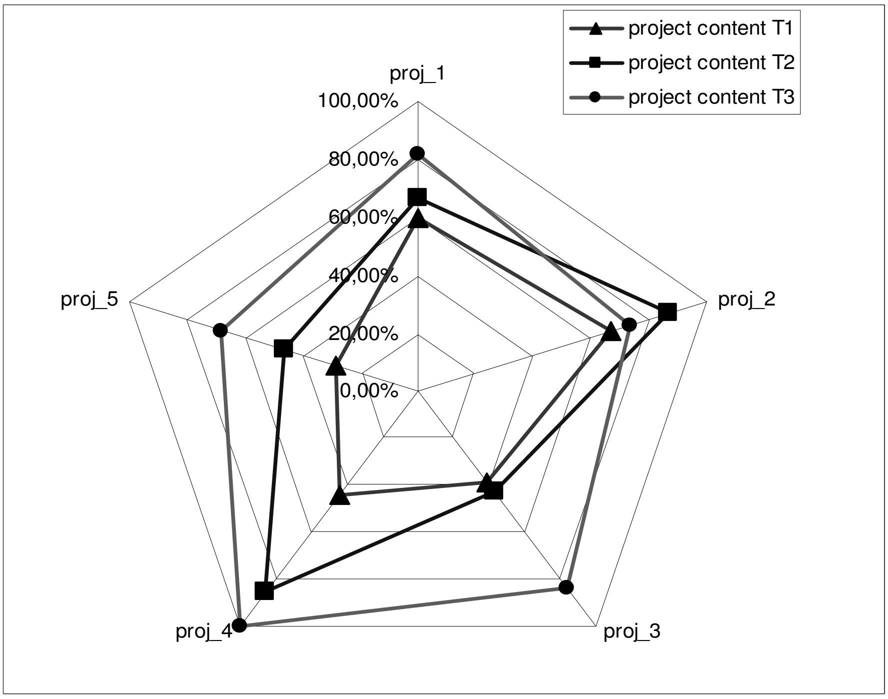
[6] network management, science-industry relations, customer-vendor relations, additionality and leverage, and internationalisation

[7] as became apparent in the course of the analysis, proj_2 was clearly emanating from cooperation prior to the present project

Fig 1: development of science-industry exchange relations on project content during the project lifetime (t_1 to t_3); densities in %



The communication of useful information (other than project content) between *science* and *industry* has developed similarly positive (see figure below). The average of the network density over all projects under scrutiny amounts to about 77 %, which is sufficiently close to the predefined benchmark of 80 % to be regarded favourable.

Fig 2: development of science-industry exchange relations on useful information exchange (t_1 to t_3) densities in %

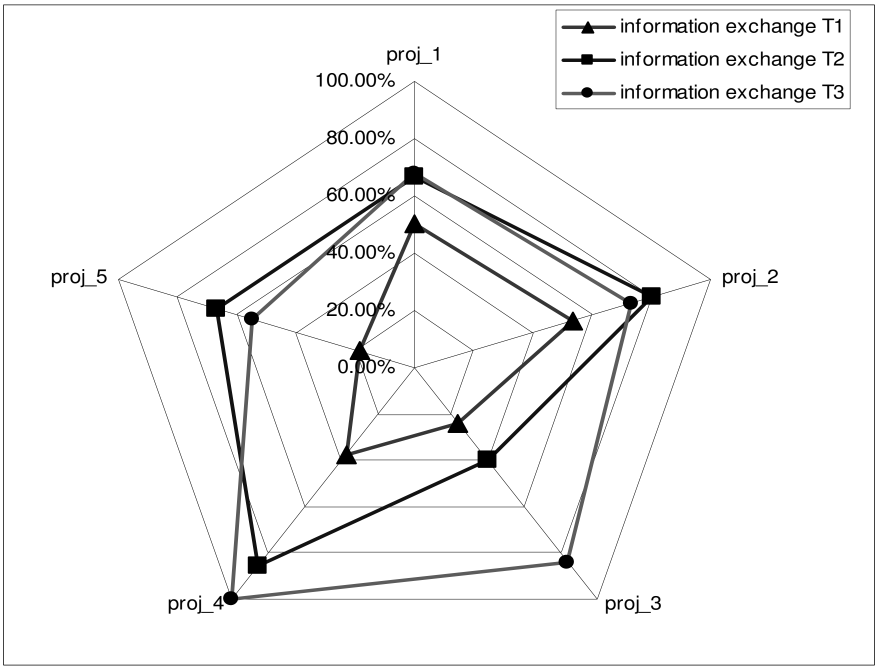
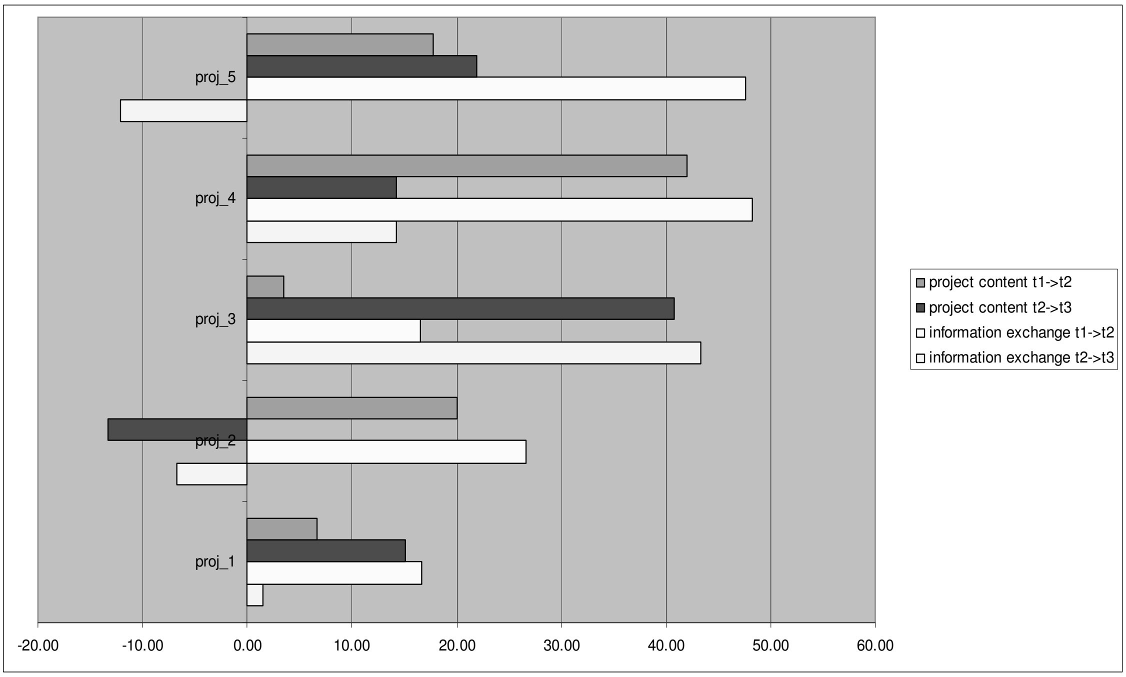


Figure 3 (see below) offers a detailed view of the network dynamics. It shows, for instance, that, regarding the exchange of useful information, proj_5 has made a very big leap in the first half of the project implementation (between t_1 and t_2) and then slackened a bit towards the end. The figure also visually confirms that the projects with a denser network at the project start develop less dynamically. It also shows that the projects differ substantially. While some projects formed on the exchange of project content during the first half of the project's lifetime (e.g. project 2 and project 4), others developed this exchange rather in the second half (e.g. project 3 which put much more emphasis on the exchange of other useful information during the first half of the project duration).

Figure 3: dynamics of science-industry exchange relations over time (t1->t2 and t2-t3) in percentage points



As stated in the hypothesis concerning science-industry exchange relations, i.e. between knowledge-"providers" and knowledge-"users", a network density of 80 % should be achieved for a project network to be regarded successful. In this respect, the network densities of the two dimensions presented here, the project content communication and the communication of other useful information, average 81 % and 77 %, respectively. We can therefore conclude that a benchmark of 80 % of realised exchange relations can be expected within publicly co-funded RTDI project as a target for success. Both dimensions show high dynamics in the first half of the project implementation. However, while the project content communication stabilises over time, the communication of other useful information may fluctuate towards the end.

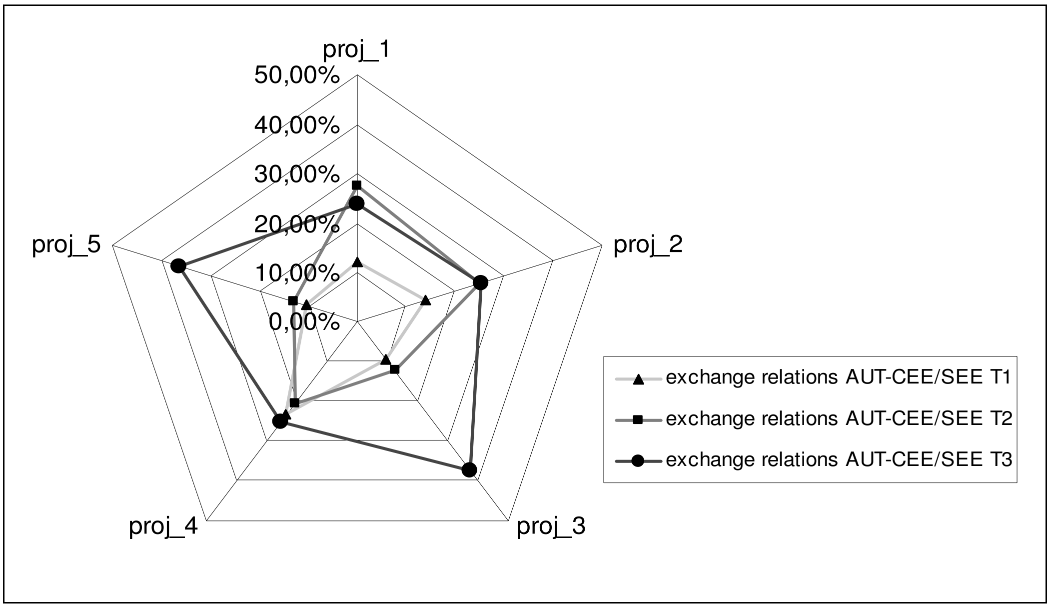
Internationalisation

The programme's goal to enhance the internationalisation of the project network partners can be approximated by the extent of realised cross-border exchange relations versus possible cross-border exchange relations. In addition, since CIR-CE is a RTDI programme unilaterally designed and funded by Austria, the relative gains of the Austrian network partners in comparison to their foreign counterparts constitute another aspect that deserves attention. Against this background, the following hypothesis was established: *In general, SMEs are only marginally engaged in international RTDI endeavours. However, since the USP of CIR-CE is its international orientation, which distinguishes it from RTDI programmes with a local or national outreach, the participating network partners are generally ready to enlarge their technological cooperation base across borders. Nevertheless, the identification of and subsequent cooperation with just one adequate foreign partner might already satisfy the internationalisation need of a SME. It is neither necessary nor always feasible to establish exchange relations with all foreign project network partners. They could be, for instance, potential competitors or simply from the "wrong" country. Thus, it is assumed that, in order for a project network to be considered successful, at least 30% of all possible exchange relations between network partners from Austria on the one side and from foreign network partners on the other should be realised.*

The result of the *"international" exchange* is an averaged measure[8] that reflects the exchanges esteemed most relevant from the internationalisation point of view. In this regard, only one project network (proj_4) showed a relatively high degree of internationalisation at the beginning of its lifetime. As can be seen in the figure below, the other networks had more to gain, in two cases in the first half of the project implementation, in two other cases in the second half.

[8] aggregating the dimensions *exchange of goods*, *services*, *money*, *valuable new contacts*, *useful information*

Fig. 4: exchange relations between Austrian partners and non-Austrian partners (t1 to t3) densities in %



The average of all "international" network densities at the end of the project duration amounts to exactly 30 %. Therefore, the predefined benchmark of 30 % of realised exchange relations across the Austrian border has been reached.

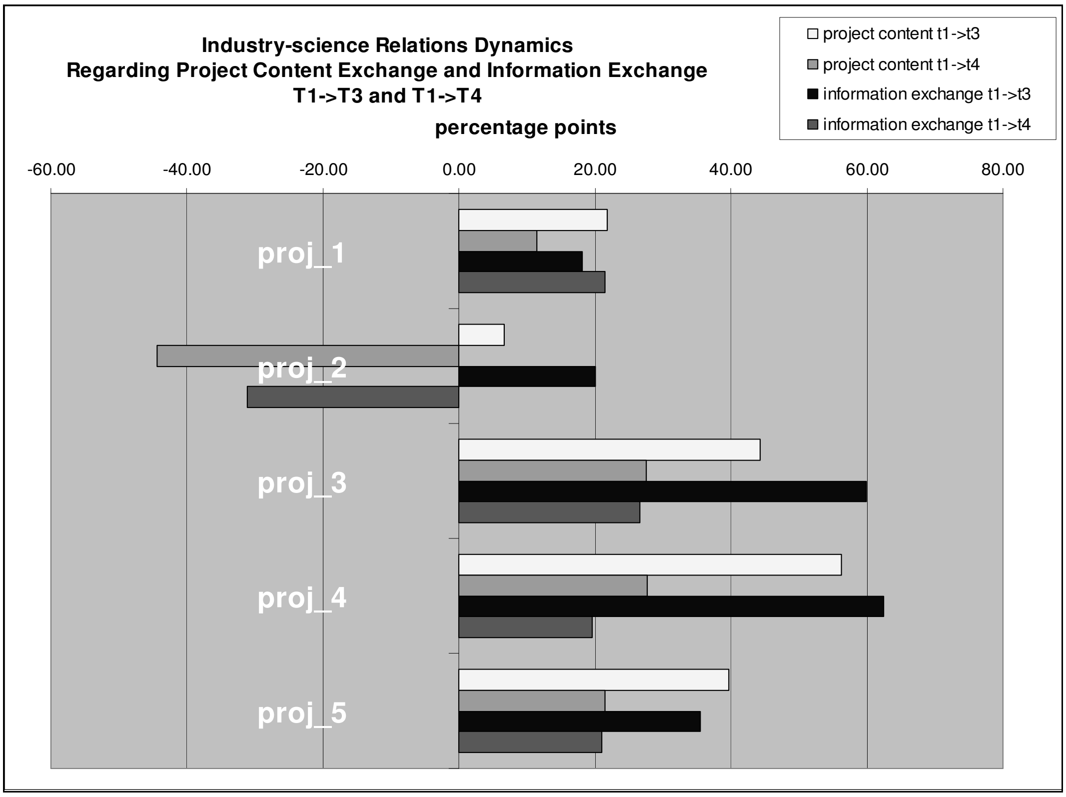
To assess the improvements of Austrian network partners in terms of internationalisation vis-à-vis the internationalisation improvements of their foreign counterparts, the realised international exchange relations including the Austrian partners were compared to the realised international exchange relations excluding them. The achieved gains along such terms could not be evaluated for proj_2 and proj_4, since both were comprised of partners from Austria and only one partner country. Thus, results for three projects are available. The findings are that, in all instances, the cross-border network density between Austrian and foreign partners was clearly higher than the cross-border network density just between the foreign partner This, in turn, allows to assess whether the programme has reached and supported its main target audience, the Austrian actors, which it has indeed.

Sustainability

The evaluation design includes a sustainability check that was to be done one year after the formal conclusion of the projects. All benchmarks were predefined to assess sustainability. Sustainability has been defined as achieved if the established relation exchanges of the network under scrutiny are higher one year after the project's official conclusion than what they have been at the beginning of the project ($T_4 > T_1$). If such an effect occurs, then a positive lasting impact of the provided public funding on the network and its internal exchange relations can be stated. If, however, the exchange relations within the network one year after the formal termination of the project (and its funding) are lower or just on the same level as at the beginning of the (former) project, then no sustainable impact can be stated.

In regard of the science-industry exchange relations, the average network density in terms of project content communication and the communication of other useful new information, is summarised in the figure below, which shows that, with the exception of one project (proj_2), the dynamics are all positive.

Fig. 5: network development of science-industry exchange relations over time (t_1->t_4) dynamics in percentage points



Four out of five projects reach or even surpass 20 % percentage points (comparing t_4 with t_1).

For assessing the sustainability of the networks in terms of internationalisation one year after their formal conclusion, the benchmarks were adapted such that the initial aggregation of dimensions (see section *Internationalisation* above) was complemented by the examination of dimensions which were expected to offer more insights. Specifically, these are information-based dimensions (rather than trade-based ones). Two networks show an increase in terms of internationalisation compared to t_1; one network showed almost no changes when comparing the internationalisation density of t_1 with t_4, and the internationalisation of two networks has even dropped below the starting level. In all networks, however, the relationships remained trustful to a satisfying degree even one year after the termination of project funding. This is an encouraging sign, meaning that an important precondition for renewed future fruitful collaboration has indeed been met.

Conclusion

For the evaluation of the project networks funded by the CIR-CE programme, methods of Social Network Analysis have been applied. They allow to measure the dynamics within RTDI project networks and to assess their development over time. Although a relatively small number of networks (five) have been scrutinised, some preliminary conclusions concerning viable benchmarks to be used in the assessment of publicly co-funded RTDI project successes can be drawn.

The results of the evaluation suggest that science-industry exchange relations are not only feasible but can be expected to be realised to a very high extent, i.e. 80 % of all possible exchange relations regarding *project content communication* or the *communication of other useful information* can be expected. Thus, science-industry relations seem to be already well practised and 'cultivated' in the Austrian context and the likelihood of sustainability of these relations is promising.

The analysis has also shown that internationalisation can be stimulated substantially by effective co-funding. A realistic benchmark for internationalisation is 30 % in terms of cross-border exchange[9],. The survey results indicate, however, that sustainability of international exchange relations should not be perceived as granted after the termination of public co-funding. Internationalisation seems to have a very responsive elasticity to public co-funding which alleviates the burden of transaction costs.

Several factors impede the generalisation of the above findings. Firstly, the benchmarks need to be aligned with the programme and its programmatic and operational framework conditions. In the case of CIR-CE, the inclusion of customer-vendor dimensions, for instance, did make sense but may not do so in other cases. Secondly, we argue that in order to evaluate the sustainability of a network, one year after the formal conclusion of a project is not necessarily an adequate period. However, this is somewhat of a tightrope walk because network partners, be it organisations or individuals, might not be around anymore to participate in a survey conducted later. In fact, this happened even after a period of only one year.

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[9] in our case an aggregation of the following exchanges: goods, services, money, valuable new contacts, and useful information

To sum it up, the results are doubtlessly contextualised and have to be adapted in any case to different framework conditions. Moreover, the evidence base of the evaluation presented in this paper is quantitatively yet too limited to establish significant signposting benchmarks. Therefore, another six networks are currently under investigation to draw *more reliable* conclusions on the development of exchange relations within RTDI networks. Further results and insights can be expected in a year or two.

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