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Regional Effects of Research and Technology Institutions – Valuation Methods along the Innovation Process: Monitoring Project Cooperation

Regional impact analyses of scientific institutions show decision makers the importance of infrastructure. The analyses follow different approaches and models, are mostly limited to previously defined effect areas and mainly investigate the effects of universities. This article shows the different evaluation methods of scientific institutions along the entire innovation process. The aim is to provide a holistic overview of methods for identifying evaluation gaps. The first section explains the difference between the linear and dynamic innovation process. Then, the method analysis along the innovation process follows. This is preceded by a critical evaluation of the methods and the definition of the focus for further work. Scenarios on regionality, frequency and dynamics describe my own analysis approach and finally result in a monitoring system of regional project cooperation.

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Introduction

Science and research generate innovations and influence the performance of countries and communities of states. The conditions vary greatly from region to region and competition for innovation is fierce. It is therefore important to examine the effects of science and research and to highlight their uniqueness for the innovation process. The innovation process starts with the input of money and personnel and goes through resource transformation to generate knowledge, networks, new products and services, and to educate highly qualified workers. Various evaluation methods reflect the different process steps and effect categories. The evaluation and measurement of the effects as well as a holistic evaluation approach are the subject of this analysis.

Innovation process

For a long time the basic understanding prevailed that the innovation process was a simple linear process with the widespread “science-to-market” idea (see Figure 1).In the linear innovation process, a direct path leads from basic research to applied research (downstream), through innovation to the broad commercial use of technologies and products on a specific market (upstream). During this time, there was a discussion about the triggering side of innovations. Some saw the demand side as a trigger for innovation (demand-pull), some attributed it to the supply side (technology-push) (Dunkel 2006). This linear understanding of the innovation process is shown in Figure 1.

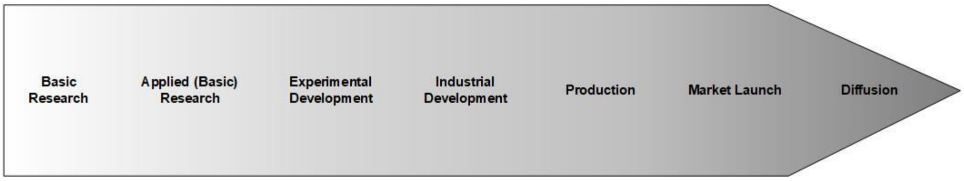

Figure 1: Linear understanding of an innovation process
Source: Dunkel 2006, p. 26

The use of the linear model of the innovation process is useful for analytical descriptions but does not correspond to the real process. Massey notes, “as we reviewed the various theories and models, we began to realise that in almost every major innovation of recent times each functional phase is linked in some way to the others; every phase in our block diagram has lines connecting it to and from every block in the diagram” (Massey et al. 1992, p.79). The turning point of the linear understanding was the Sundqvist Report in 1988: “The interdependence of technical change, economic and social change is in its development and application fundamentally a social process, not an event, and should be viewed, not in static but in dynamic terms” (OECD 1988, p. 11). The real innovation process is complex, cannot be assigned to an extreme value (“demand-pull” or “technology-push”), and consists of feedback, knowledge transfer and relationships between the process actors. Innovations arise at all phases of the process. In contrast to the linear innovation process, the actors interact always and at all times in order to manage the ever-changing conditions (knowledge base, demand for technologies, etc.). The interactive model of the process is understandable as a system of interactions, a system of many movements between individual functions and actors whose experience, knowledge and knowledge reinforce and complement each other. Within the system, two types of interactions occur. The first interaction is within a company or enterprise network, the second is between business and science (see Figure 2) (Dunkel 2006, p. 28).

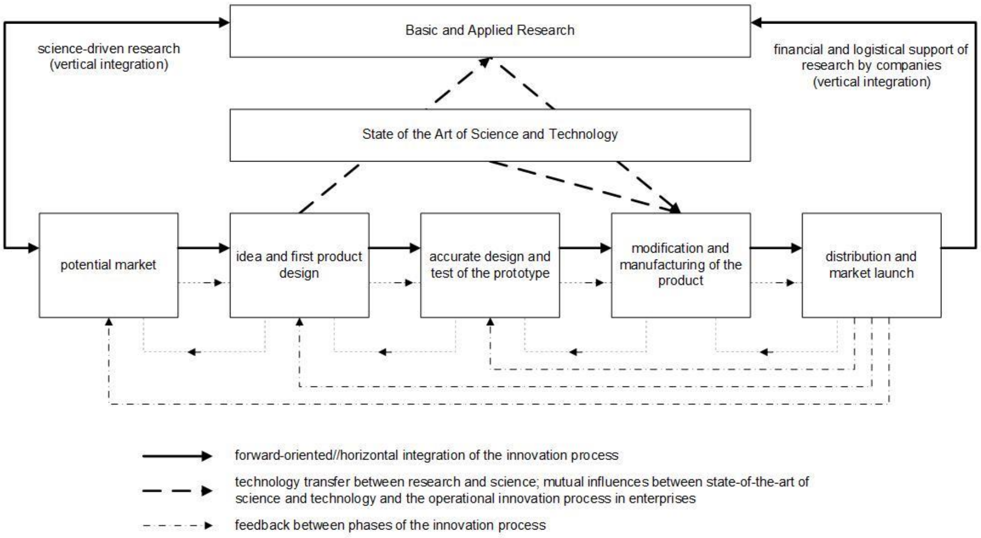

Figure 2: Interactive and dynamic model of the innovation process
Source: based on Dunkel 2006, p. 29

The innovation chain on the corporate level consists of five phases (first interaction type). Perceiving new market opportunities and new science or technology-based inventions with the help of an early warning system is the subject of the first phase. The second phase is realizing the idea and the first product design, and is followed by the accurate design, including the prototype test. The analytical design is important because, “design activity is not a lower level or routine activity, but one which can originate a number of linkages and feedbacks. A design (...) is essential to initiating technical innovations, and redesigns are essential to ultimate success. In many industries, this design activity still incorporates tacit knowledge and technical know-how dating back to earlier periods when production had a weak or even no base in science at all” (OECD 1992, p. 26). The modification and manufacturing of the product is part of phase four. The last phase on the corporate level is the distribution and the market launch (Dunkel 2006).

At the corporate level, feedback occurs in different ways. Short feedback is on the connection between each subsequent (downstream) phase; long feedback connects the demand or the user with the upstream phases (non-adjacent phases). Another linkage exists between the entrepreneurial innovation process to the state-of the-art of science and technology and to the basic/applied research (Dunkel 2006).

The second interaction type describes the linkage between the innovation processes of companies with those of science and research. Here a constant learning and development process takes place in all innovation phases and generates new knowledge and new resources. The development of a new knowledge base is the service of science and research for the companies (Dunkel 2006).

The knowledge base of companies often shares information about technical features, performance indicators, use of materials, or management solutions. This is the generic level of a technology: “On the one hand a technology consists of a body of knowledge, which I shall call generic, in the form of a number of generalizations about how things work, key variables influencing performance, the nature of the currently binding constraints and approaches to pushing these back, widely applicable problem-solving heuristics, etc. I have called this the ‘logy’ of technology (...). Generic knowledge tends to be codified in applied scientific fields like electrical engineering, or materials science, of pharmacology, which are ‘about’ technology” (Nelson and Winter 1982, p. 75).

Valuation methods

The use of the linear model also occurs here because it is very well suited for scientific analysis. Nevertheless, we keep the real, dynamic innovation process with its feedback in mind and analyze the valuation methods in terms of dynamics. The analysis of the valuation methods takes place in the following phases:

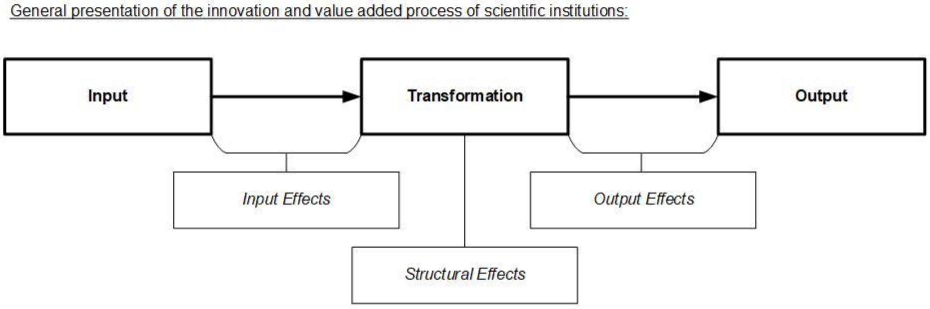

Figure 3: General presentation of the innovation and value-added process of scientific institutions
Source: Own compilation

Input, transformation and output divides the innovation and value-added process of scientific institutions into three phases. Enablers for fulfilling the duty of scientific institutions are the capital, the scientific staff, and the equipment. Duties of scientific institutions are “the operation of research and teaching, further education, and knowledge and technology transfer” (Sauerborn 2005, p. 148) at universities and professional schools or, with reference to the non-university institutions, “the entire spectrum of basic research on some internationally unique infrastructures for industry-related, application-oriented research” (BMBF 2018, p. 81). In non-university research institutions, the teaching and training mission is not as important as it is in universities and professional schools (Franz et al. 2002). The transformation phase combines the provided resources to perform best, e.g. working on research projects, developing new knowledge and providing knowledge for the community. The dissemination and discussion of transformational findings is extremely important so that they can be of value to the knowledge community and society. Therefore, the output completes the innovation process. Increasing the competence of employees through project work, the public accessibility of research results, patent applications, development of new products and services or creation of start-ups are outputs of scientific institutions.

Table 1:
Valuation methods of the input, transformation and output phase

Input	**Transformation**	**Output**
Multiplier Analysis	Descriptive Analysis	Empirical Analysis of Human Capital Effects
		Location Effect Analysis
Input-Output Analysis	Multivariate Analysis - Logit Regression - Matched-Pair Approach	Network Effect Analysis
Functional Chain Analysis		Keyword Analysis
Self-financing Effect Analysis	Cooperation Analysis	Descriptive Analysis
	Joint Research and Contract Research Analysis	Economic Performance Analysis - Random Effects Approach - Fixed Effects Approach - Tax Multiplier Analysis

Source: Own compilation

The evaluation of the innovation and value-added process and the comparison of the effects of scientific institutions are difficult. On the input side, financial and human capital are primarily considered, and on the output side, knowledge capital. This makes it difficult to compare the effects.

Table *1* gives an overview of the evaluation methods of the input, the transformation and the output of research institutions. The presentation and explanation of each method will follow.

Valuation methods of the input

Multiplier Analysis

Multiplier Analysis estimates the direct and indirect income and employment effects of a scientific institution (Rosner and Weimann 2003; Assenmacher et al. 2004; Glorius and Schultz 2002).

This method goes through the following steps:

1. Determination of the direct demand effects from the outflow of funds of the scientific institution.
2. Estimation of indirect demand effects using a region-specific multiplier value.

Input-Output Analysis

Input-Output Analysis is equivalent to the multiplier analysis described above. The tool for this methodology is the input-output matrix. There are three sectors in this matrix: the supplying, the supplied and the primary input sector (taxes, imports and value added). Here, a regionalization takes place by using the derivative method, since no regional data or regional input-output tables are available. The derivative method is based on an adjustment of general available data, here in the aggregation of sectors, the calculation of the interrelation coefficient, the assumption of a regional reflection by the national input-output-matrix and the associated determination of the regional preferential rate and the final valuation of the Leontief inverses(Rosner and Weimann 2003).

Functional Chain Analysis

Functional Chain Analysis determines the indirect effects in the first round of impact measurement. The focus here is on the sector-specific employment effects that arise because of the expenditures of the scientific institution. Tools for the calculation of employment effects are the workplace coefficients of individual sectors. This coefficient represents the average financing per job (average turnover of one employee per sector). Therefore, a derivation of the resulting jobs from the amount of expenditure of an institution is possible (Glorius and Schultz 2002).

Self-financing Effect Analysis

The self-financing effect analysis indicates which financial share of the scientific institution is self-financed. Therefore, the following information is necessary:

- the most important tax sources of the federal states: compound taxes (income and value added tax, vehicle tax, transfer land transfer tax);
- its own tax revenue has no influence on the fiscal revenues of the federal states, differences are adjusted by regulations of the German Federal State Finance Equalization;
- revenues of the federal state are defined by the number of inhabitants and the per capita tax revenue;
- the approximation of fiscal per capita revenue is determined by a financial strength indicator and a compensation indicator for each federal state;
- the financial strength indicators define the financial strength of a federal state and the compensation indicator defines the financial need of a federal state.

This self-financing effect results from the fiscal income of an additional inhabitant in the federal state. The analysis of the fiscal income takes place with a limit calculation. The multiplication of the financial strength indicator with the compensation factor, divided by the number of inhabitants in the federal state, results in the fiscal marginal income. Fiscal marginal income multiplied by the number of additional inhabitants (e.g. number of students, new employees in the scientific institutions with origin in another federal state) gives the income of the German Federal State Finance Equalization. This income divided by the expenses for the scientific institution gives the self-financing rate of the scientific institution (Rosner and Weimann 2004).

Valuation methods of the transformation

Descriptive Analysis

Descriptive analysis within the transformation phase brings together regular surveys of companies on their cooperative behavior with a scientific institution. Among other things, the content of these surveys is the answer to the question of whether a company cooperates with the research institution or not. Based on the surveyed companies, the proportion of cooperating companies can be determined. The determination of the cooperation intensity is possible by the number of projects. Further content of the survey is the sector allocation of the (cooperating) companies, turnover, number of employees, work productivity per employee, age of the enterprise, research priorities, most important field of innovation, position in the value chain, product complexity, technology use as well as production and work organization(Fraunhofer-Institut für System- und Innovationsforschung ISI 2016).

Multivariate Analysis

Multivariate analysis tests the previously established relationships with the help of two consecutive methods and additional variables. The first method is logit regression. The aim of the method is to estimate the connection within a cooperation, to measure the innovation performance of companies and their cooperation intensity. The second method is the matched-pair approach. Here, the comparison of a cooperating company with a defined twin company takes place. This makes it possible to say whether a cooperating company is more successful than a non-cooperating company. By not making parametric assumptions, the matched-pair approach is much more robust than the regression-analytic approaches (Fraunhofer-Institut für System- und Innovationsforschung ISI 2016).

Cooperation Analysis

The cooperation analysis examines whether there is a direct connection between a cooperation with a scientific institution and the company's success. A relationship is measurable via financial ratios. The data used here consists of the European Manufacturing Survey[21]and the ORBIS database[22].Variables on which the relationship is established are the revenues from the main business activity, earnings before interest and taxes (EBIT) and return of equity (ROE) (Fraunhofer-Institut für System- und Innovationsforschung ISI 2016).

Joint Research and Contract Research Analysis

The Joint Research and Contract Research Analysis evaluates the proportion of all collaborative projects involving the respective scientific institution. Data from the federal funding catalog (BMBF) and internal contract research data form the basis of this analysis over time. With this data it is possible to identify partners who begin as collaborative project participants and then become industrial project partners (Fraunhofer-Institut für System- und Innovationsforschung ISI 2016).

Valuation methods of the output

Empirical Analysis of Human Capital Effects

The Empirical Analysis of Human Capital Effects examines the complexity and the transfer paths of knowledge and human capital into the regional economy. Three transfer paths play an important role:

1. spin-offs from the scientific community;
2. cooperation and knowledge transfer between science and regional companies;
3. graduates working in regional companies.

The research design varies from personal interviews to written surveys (questionnaires). The results of the analysis include the number of spin-offs, regional distribution of spin-offs, forms of knowledge transfer (cooperation, contracts, patents, further training), forms of human capital transfer (trainees, graduates, external staff), environmental factors for cooperation, cooperation potential and obstacles, structure of regional enterprises (size, sales markets, innovation behavior), and criteria for the selection of scientific institutions (Rosner and Weimann 2004).

Location Effect Analysis

Location Effect Analysis indicates whether students remain in a region in relation to the regional labor market and the size of the total labor market of a country. The relative size of the labor market defines the expected number of graduates starting their careers in the state. Only the attractiveness/unattractiveness of the regional labor market and the location effect of the

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[21] European Manufacturing Survey (EMS) is a consortium of research institutes and universities of several European and non-European countries which analyzes the use of technical-organizational innovations in production; the EMS is organized by the Fraunhofer ISI.

[22] The ORBIS database includes information of 310 million companies worldwide.

university influences this expected number. Surveys and statistical data help to define the needed information for a specific year. The site effect describes how many additional graduates above the average number will remain in the region, just because the federal state finances the scientific institution. Labor market attractiveness describes the deviations between expected and actual numbers of remaining students due to the particular attractiveness or unattractiveness of the regional labor market (Assenmacher et al. 2004).

Network Effect Analysis

Network Effect Analysis examines the involvement of a scientific institution in networks. The evaluation assumes that the formation of networks promotes positive regional development because of rapid access to knowledge. Elements of the analysis are the presentation of the network approach, the emergence of networks with the help of the transaction costs approach, characterization of innovation networks, description of knowledge transfer and the definition of the role of scientific institutions in the innovation system. Empirical surveys of professors and regional companies examine the involvement of the scientific institution in these networks. Both perspectives provide insights on collaboration with other science, businesses and public institutions in the region (number of contacts, contact range, contact allocation, types of contact, content and goals, contact reasons, origin, duration and emergence, obstacles, and other characteristics) (Assenmacher et al. 2004).

Keyword Analysis

Keyword analysis answers the question of when a technology moves from theoretical knowledge to practical application. This method searches for keywords within the abstracts of patent applications over time. The first step of this analysis is the cleanup of abstracts (removal of words without content). The second step consists of the relevance verification of the potentially relevant words. It calculates how often a word occurs in a text, weighted by the number of texts in which it appears at all. Characteristic of the early phase of technology development are broad, descriptive keywords. The application of a technology becomes recognizable in other keywords (Fraunhofer-Institut für System- und Innovationsforschung ISI 2016).

Descriptive Analysis

Descriptive analysis within the output phase compares among other things the macroeconomic effects of universities and non-university institutions. There are effects in terms of third-party revenues, investment expenditures and scientists per capita. Here, annual reports and official statistics are data sources (Fraunhofer-Institut für System- und Innovationsforschung ISI 2016).

Economic Performance Analysis

Economic performance analysis focuses on the impact on GDP per capita and economic effects occurring especially because of third-party revenues. The evaluation of these effects differs, on the one hand the Random-Effects Approach (RE) and on the other the Fixed-Effects Approach (FE). The FE approach is more robust to unobserved, time-constant heterogeneity, but the RE approach is more efficient, more accurate, and less susceptible to outliers (Fraunhofer-Institut für System- und Innovationsforschung ISI 2016).

Tax-Multiplier-Analysis uses the previously determined coefficient of the FE approach for further calculation. Multiplying the coefficient by the adjusted project revenues (income from abroad excluded) results in the absolute GDP effect. This GDP effect indicates the sum of the country´s GDP generated by a scientific institution. With this value and the determination of the tax rate in the corresponding year (total tax revenue divided by GDP), the calculation of the expected tax effect of a scientific institution is possible (tax rate multiplied by the GDP effect).Considering the corresponding financial requirements or public financing (publically funded projects and basic funding) of the scientific institution, a respective tax multiplier is obtained (Fraunhofer-Institut für System- und Innovationsforschung ISI 2016).

Review of valuation methods

The analysis of the methods during the general innovation process shows a focus on the determination of monetary effects. To improve the comparability of the effects, attempts are made to convert knowledge and network effects of the output into monetary units. The differences between the methods on the input side (quantitative assessment of effects) and the analytical procedures on the output side (qualitative assessment of effects) are still formative. Both sides are still put in relation to each other in order to obtain better statements on the effectiveness of expenditures. This means that a precise statement on the quality of research is neglected here.

The transformation phase of the innovation process has so far received little methodological support and reveals the research gap. Working in projects, one of the core activities of a research institution, has so far been little or not at all investigated. Projects with external companies and partners are of interest here because this work has internal and external effects. When the projects were examined, this usually had a financial background in the methodology. For this reason, besides the extension of the quantitative project evaluation, the qualitative analysis of the projects carried out is important for further work.

The origin of effects in the transformation phase is the cooperation with partners from science, business, industry, culture, politics and society. Due to the cooperation, research institutions have further influences (see Table 2). Therefore, methods are needed to examine and evaluate cooperation, network activities and cooperation between companies – methods that deal with the evaluation of projects – in order to take a closer look at this cooperation.

The evaluation of the effects on the subsystems described in Table 2 has its limits. In particular, the attribution, utilization and the occurrence of effects with a time and place lag poses an enormous methodological problem. Such impact assessment requires a large time frame and an immense database.

Table 2:
Effects on subsystems

Subsystems	**Regional environment**
political	higher political participation, better organization of political processes
demographical	size, structure and mobility of the population
economic	economic structure, labor mobility
infrastructural	housing market, transport, medical infrastructure, shop density
cultural	greater supply and demand for cultural events and facilities, general influence on the cultural climate
pedagogical	educational participation and quality
social	quality of life, image and identity of the region

Source: Haisch 2008, p. 18

The data used so far in the methods consist of individually recorded databases of companies, research institutions, the federal government or the respective federal state. These are neither structurally, conceptually nor content-wise identical and contain hardly any information on effects on the regions. At this point, it would make sense to define uniform mandatory information for project documentation and to add important categories.

Uniform mandatory information can be, among other things, the distinction between grant recipient and implementing agency in order to clearly assign projects to regions; to use a generally applicable industry categorization (e.g. WZ 2008[23]) in order to assign companies to the industry in which they have the largest share of value added (gross value added at basic prices); a common understanding of the classification of enterprises according to their size (micro, small, medium-sized, large enterprises) and a general classification of projects (project type, project size, project complexity). With regard to the project type, it is interesting to know whether it is an individual project, a collaborative project or a joint project, whether it is an industrial project or a public project, and whether it is an initial project or a follow-up project.

As additional categories for project documentation, it would be useful to distinguish between innovation types (on the one hand in the project objective and in the actual project result) in order to make a more visible characterization of regions or developments. Several distinctions can also be made at this point: object of the innovation, scope of change of the innovation, range of the innovation, driver of the innovation, market impact of the innovation, etc.

If the project evaluation is extended, it makes sense for various reasons to combine the different approaches of project documentation, to design an appropriate monitoring system and to develop additional indicators for regional development. These are indicators which, due to a lack of data, can only be determined by way of example, but represent a first approach, an approach that exemplifies the regionality, frequency, intensity, dynamics and characteristics of regional cooperation.

Scenario for the regionality, frequency and dynamics of projects

The evaluation of the *regionality of the projects* or the localization of all project partners allows statements to be made about the spatial area in which the work of a research institute has an impact. When looking over several years, this spatial area should be extended, but at the same time should focus on a specific catchment area. This means that when a research institute is founded or established, it can be assumed that its activities in the first year will be concentrated in a narrow radius around the location. Over the years, this circle becomes larger and larger, crosses national borders and does not neglect its own environment. As a result, a determination of project shares at local, regional, national and international level could help to identify and counteract certain developments in cooperation.

Scenario Regionality: The imaginary data set for the cooperation in projects has changed as follows in recent years, as Table 3 demonstrates.

Table 3:
Scenario Regionality

	2000	2010	2020
German Federal State	50%	40%	35%
Germany	35%	40%	45%
Europe	10%	10%	15%
World	5%	5%	5%

Source: Own compilation

With such a distributional development in cooperation, the regional share is steadily decreasing, in contrast to the increasing share in Germany and later in Europe. Due to its location, the research institution has the task of supporting the region in global competition, contributing to positive development and orienting its research topics to the regional needs, especially in the surrounding area. It is also worthwhile to divide the regionality into several

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[23] WZ 2008 is the German Classification of Economic Activities Edition 2008 and the equivalent of the European Classification of Economic Activities (NACE = Nomenclature statistique des activités économiques dans la Communauté européenne)

dimensions, such as municipalities, federal states, neighboring federal states, regions of Central Germany or old/new federal states, in order to obtain a clearer picture of the regionality.

The *frequency of cooperation* refers mainly to the interaction between companies and research institutions. Here the innovative spirit of companies can be deduced. In other words, the more often projects are carried out and the less time passes between projects, the more innovative companies are.

It is important to classify the companies according to their size and to divide the projects into funded and nonfunded. The size of an enterprise is associated with the ability to implement its own research projects. This means that large companies have their own research and development departments, carry out their own projects, seek support from external sources less frequently and, if necessary, commission these research institutions directly (non-subsidized projects). Small companies, on the other hand, do not have their own research sections, therefore do not carry out their own innovation projects, look for a competent partner for this activity and are usually looking for funding to implement a project.

Scenario Frequency: The imaginary data set for the frequency of regional cooperation, over a defined period, considering the project type and the company size, is shown in Table 4:

Table 4:
Scenario Frequency

project type	funded			nonfunded		
company size	small	medium	large	small	medium	large
number of projects	25	30	10	10	15	30
average time between projects (in months)	24	18	12	36	24	6

Source: Own compilation

With such a distribution of the number of projects, SMEs cooperate particularly intensively with research institutions in funded projects and large companies are more likely to cooperate with research institutions in nonfunded projects. It is also clear that the smaller a company, the longer the average time between both funded and nonfunded projects. These companies consider each innovation activity very carefully in order to minimize the economic risk. Of great interest here is the question of the interplay between funded and unsubsidized projects, i.e. how many unsubsidized projects are initiated by a subsidized project.

The *dynamics of regional cooperation* are based on the evaluation of the frequency of projects. Here, the duration of the projects, the sum of all project durations and the time coverage over the period between the first and the last project are decisive. Thus, a certain regularity can be identified in the cooperation between companies and research institutions.

For the evaluation of the temporal coverage two factors of regional cooperation must be determined. One is the time from the beginning of the first project to the end of the last project and the other is the sum of all project durations.

Scenario Dynamics: The imaginary data set for the dynamics of regional cooperation are to be depicted as in Table 5 over a defined period, considering the type of project and the size of the company:

Table 5:
Scenario Dynamics

project type	funded			nonfunded		
company size	small	medium	large	small	medium	large
number of projects	25	30	10	10	15	30
sum of project durations (in months)	150	270	180	30	90	360
average project duration (in months)	6	9	18	3	6	12
observation period first and last project (in months)	60	48	36	36	30	24

Source: Own compilation

Such a distribution of the time factors of projects shows that the average project duration varies depending on the type of project and is higher in funded projects than in projects implemented with an organization's own funds. This also results in a lower sum of project durations, which means that projects have a longer time interval and a correspondingly longer observation period[24]. Looking at individual companies, the phenomenon of a longer time span between projects than the sum of the project durations can occur, and this can mean that the cooperation is only covered for a short time.

Monitoring system of the regional project cooperation

At the end I would like to briefly introduce the monitoring system with individual illustrations. Ideally, such a system should be applicable to every research institution in Germany, characterize the work of a research institution even better and reveal differences in the project work of regions. In addition, it can be used as an instrument for the targeted management of project funding to strengthen structurally weaker regions.

Regionality can be displayed in heat maps (Figure 4). All projects of a research institution in Magdeburg (Saxony-Anhalt) with companies in the same federal state are combined here. The dashboard is designed in such a way that the presentation adapts to the project type (all, funded, non-funded, etc.), the calendar year and the region (federal state, own federal state plus neighboring federal states, new and old federal states, etc.) depending on the settings selected.

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[24] Oberservation period is the time between the first project (project start date) and the last project (project end date) with one project partner. That means, every project partner has an individual observation period.

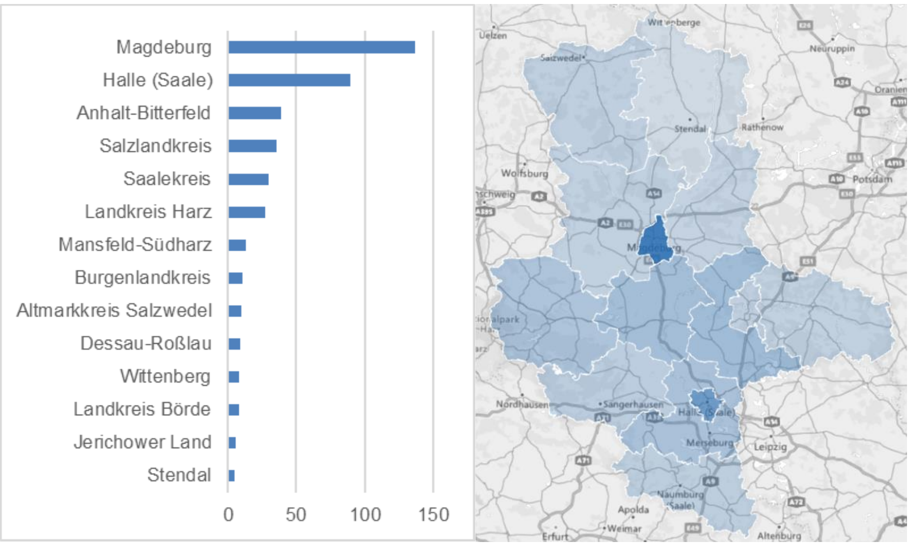

Figure 4: Monitoring of regionality: number of project cooperation of a research institution based in Magdeburg by county districts within the Federal State of Saxony-Anhalt (imaginary data left, heatmap right), darker colors mean more project cooperation
Source: Own compilation

The frequency of regional cooperation is presented in Figure 5 as a comparison between funded and unfunded projects; the calendar year can also be selected here. In the further course of the dashboard development, the process of trust building between the project actors will be examined. This also determines how often and in what time interval a direct industrial project arises from a funded project. By showing the frequency of regional cooperation in funded (left side) and nonfunded projects (right side), the need and demand in the region becomes clear. The more frequently cooperation is requested in funded projects, the greater the competence in writing project proposals must be developed in the research institution. And vice versa, the more frequently cooperation is sought in nonfunded projects, the greater the professional and technological competence must be in the research institution.

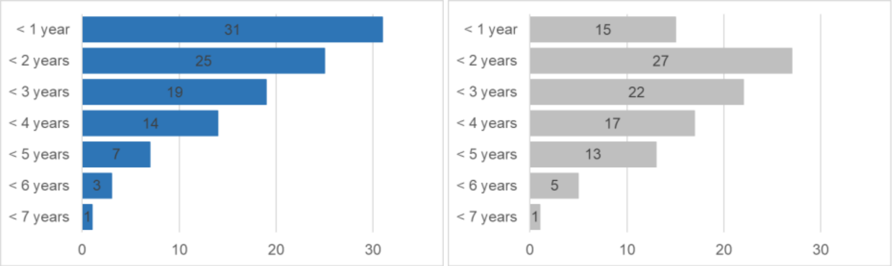

Figure 4: Monitoring of Frequency in funded (left) and nonfunded projects (right)
Source: Own compilation

The dynamics of regional cooperation is also presented as a comparison of funded and nonfunded projects in Figure 6., Project characteristics such as durations and intervals between follow-up projects become clear here. In relation to specific clients or project partners, peak times are discernible which indicate technological or thematic problems within the company.

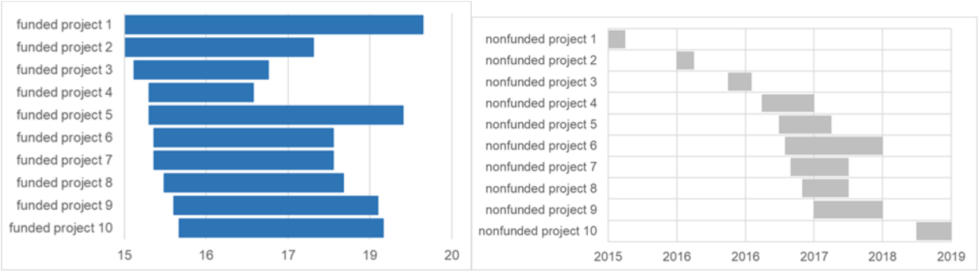

Figure 5: Monitoring of dynamics from 2015 to 2020
Source: Own compilation

With these and other characteristics of regional cooperation represented in the monitoring system, innovation developments in regions can be better evaluated and controlled. Decision makers can use this system to better assess and support regions in their innovation work. A requirement for the quality of the dashboard is, as already mentioned, the use of uniform terminology, data collection of projects by different actors of the innovation system and the compilation of these data. In this way, both a short-term assessment and long-term development can be depicted.

Collection and interpretation of further project characteristics is the subject of future work. The next steps will be to expand the theoretical monitoring system of regional cooperation, which is only abridged here, and to identify the appropriate form of presentation. The focus remains on the transformation phase of the innovation process.

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