Deliverable 5.3 Report assessment match/mismatch and issues with combined funding

BOOST FINANCING OF LARGE RDI INITIATIVES | EU-Great!

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Contributors	Marcel de Heide, and Maurits Butter (TNO)
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TABLE OF CONTENTS

Introduction

This report results from the H2020 project entitled "EU-GREAT!".[1] Objective of the report is to assess how to finance the set-up and / or continuation of what is defined as Large-scale RDI initiatives (LSIs, see Box 1). The report analyses the potential use of different public and private funding sources, and how these can be combined. The analysis will result in initial recommendations for adjustments in governance and policy addressing public and private institutions.

Box 1: Definition of an LSI

Large-scale research, development, and innovation initiatives (LSIs) are defined within the framework of EU-GREAT! as "industry and application driven, long-term, broad (open) access, multi-stakeholder partnerships strategically targeting large-scale research, development and innovation activities using a combination of different funds aiming at accelerating the commercialisation of technology, boosting competitiveness of companies and renewing industrial ecosystems towards sustainable economic growth and well-being of society." They can be considered in practice as Public Private Partnerships (PPPs) defined by cost-intensive research infrastructure, addressing the later stages of the innovation process (i.e. pilot production and demonstration).

This report builds on prior results of the EU-GREAT! project, including an extensive exercise in which business and investment plans were developed for five different LSIs. The approach to build these plans involves, besides desk-research, also interviews with relevant stakeholders in the LSI from RTOs and governmental (funding) institutions. Also external financiers involved in equity and debt financing were involved.

Box 2: The EU-GREAT! project

Objective of EU-GREAT! is "to identify the key issues combining different funding mechanisms to support scale up of research into commercial manufacturing in large scale RDI initiatives. Next to this overall objective, the impact of the project is to further initiate the development of these RDI initiatives, using a combination of different funding mechanisms. This is being facilitated with concrete deliverables, being both recommendations to policymakers and private investors to improve the combination of funding, as well as manuals for organizations to setup investment plans for RDI initiatives using a combination of funding mechanisms."

The rationale for EU-GREAT! stems from the observation that more funding is needed to bridge the gap between the laboratory and the market and both public and private sectors must join forces to increase the number of large-scale RDI initiatives (LSIs) in Europe in order to ultimately boost the commercialisation of new technologies, products and services, able to strengthen the competitive-edge of the European Industry (bridging the so-called 'valley of death').

Stakeholders of large-scale RDI initiatives often have to deal with the challenges of applying for, and combining, funding from different public and private sources including European Structural and Investment Funds (ESIF), Horizon 2020, as well as national, regional and private investment programmes, to build and manage a portfolio of synergetic projects.

The first chapter addresses the role of LSIs in the innovation process. The second chapter describes the financing needs of LSIs, and how they could be addressed by revenues and additional investments. The last chapter assesses how these modalities of financing could be combined, and what are their limitations. Initial suggestions on how to improve their effectiveness are included. As such, the structure of the report follows the suggested outline for the formulation of an investment plan of an LSI, as presented in Deliverable 5.5 and the interactive website of the EU-GREAT project: i) costs are identified for the set-up or continuation of an LSI; ii) revenues are subsequently assessed that address these costs; iii) potential investments are analysed to address the (potential) financing gap between costs and revenues.

[1] See www.eu-great.com.

Over 60 interviews have been conducted within the framework of this report, and other reports drafted within the framework of the EU-GREAT project that have provided input for this study. The interviewees include actors involved in the set-up of the respective LSIs, policy makers, external financiers, etc. We'd like to thanks them for their valuable contributions. Their valuable input has been incorporated in this report with the objective of ensuring that specific opinions cannot be linked back to a single person or organisation.

The role of LSIs in the innovation process

It is acknowledged by policy makers that, especially in Europe, innovation tends to halt at the later stages in the innovation process. The innovation system in the EU produces a relatively high level of quality research, but is characterised by a suboptimal level of valorisation of the corresponding knowledge into economic and societal benefits. It is subsequently argued by policy makers that knowledge does not cross "the valley of death"; at the crucial stage of pilot production and demonstration in the innovation process, the transformation of product prototypes to market oriented (mass) production is hindered.

Box 3: The role of pilot production and demonstration in the innovation process

Introduction of an initial idea into the market requires the implementation of a complex and often cost-intensive innovation process. A widely used framework to assess this innovation process is given in Figure 1.

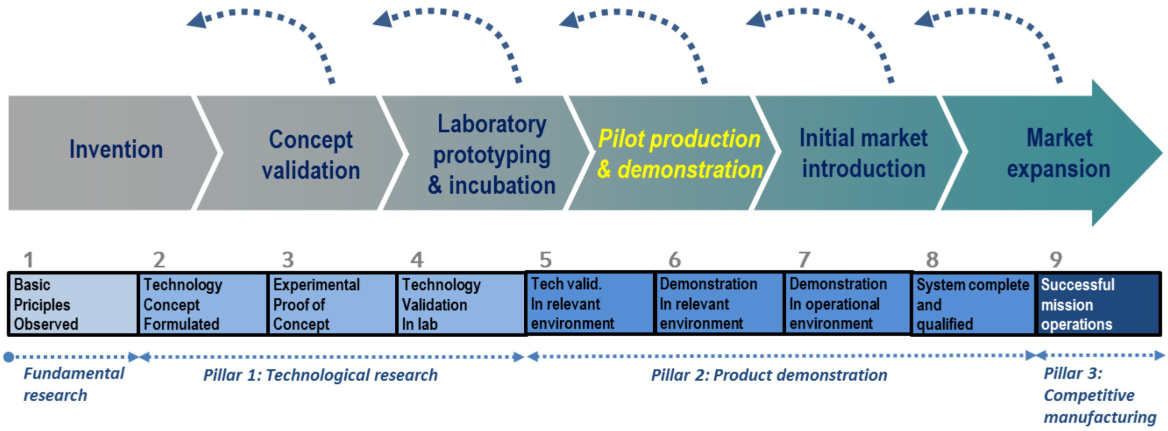

Figure 1. Stages in the innovation process

The framework identifies three fundamental stages in the innovation chain of new products:[2]

1. ***Technological research***, where scientific research transforms fundamental research into technologies.
2. ***Product demonstration***, where technologies are exploited to create product prototypes and develop facilities to fabricate a significant quantity of innovative products to establish a product validation and demonstration in terms of user performance.
3. ***Competitive manufacturing***, where the validated products and production systems are fully developed to enable competitive production in economic viable and international environments.

[2] This representation of the innovation process is based on the work of the EU High Level Group on Key Enabling Technologies (HLG-KETs), and links to the Technology Readiness Level (TRL) approach developed by NASA. Note that we assume that the innovation process is not linear process. During all stages it might be necessary to go back to a previous stage. For example a company might notice during product demonstration that more technological research is needed.

LSIs are Public Private Partnerships (PPPs) that provide critical and costly research capacity and infrastructure at the pilot production and demonstration phase of the innovation process (see Box 3).[3] In this chapter, we show that LSIs have a positive impact on the innovation behaviour of companies. We also argue that LSIs provide a basis for effective / efficient modality of public support, addressing specific forms of market failure. As such, LSIs represent an important policy solution for addressing the valley of death.

Pilot production and demonstration: investment decision by firms

Analysis within the framework of the EU Multi Key Enabling Technologies Pilot lines project indicates that firms are reluctant to invest in the phase of pilot production and demonstration of the innovation process.[4] Assessment of the underlying rationale for a negative investment decision suggests that firms in that case estimate that the uncertainty concerning the outcome of the innovation process is such that the required investment to cover the costs of pilot production and demonstration cannot be recovered. They phrase this in that case as: "[…] the economic risk is too high."

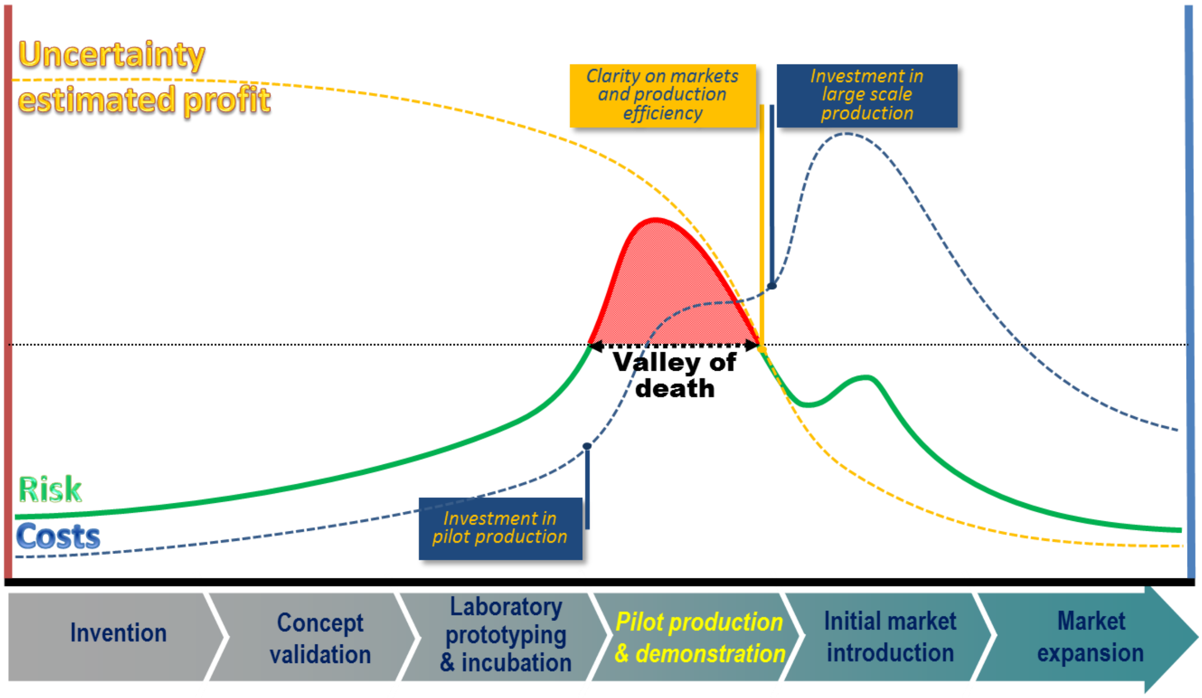

Figure 2. The perception of economic risk during the innovation process (Source: mKETs pilot line project)

Figure 2 provides insight in an important question: why the innovation process halts often at the stage of pilot production and demonstration. The figure captures developments in required investments (reflected as costs), uncertainty about the outcome, and resulting perception of "economic risk" over the innovation process.

[3] Public Private Partnerships (PPPs) are defined her in the broadest terms; as a form of collaboration between private actors and (public) knowledge institutes, that are (partly) publically funded.

[4] See www.mkpl.eu.

Figure 2 indicates that at the stage of pilot production and demonstration the costs associated to the innovation process increase dramatically, such that they are significantly higher than in previous stages. Uncertainty about the outcomes decreases during implementation of the innovation process, but at the stage of pilot production and demonstration, changes in estimated profit and required investments are very much out of phase. This subsequently provides the conditions for a negative decision on investment in pilot production and demonstration (i.e. firms are afraid that they are not able to gain back the costs associated to pilot production and demonstration).

Another important question is why the innovation process does not halt before the pilot production and demonstration stage (i.e. "why start at all if potentially insuperable conditions will arise at a later stage ?"). Literature is not decisive on this, and the issue is subject to further research. Several (combinations of) different explanations seem plausible:

- It is suggested that especially for smaller companies, it is difficult to assess the required investments in the later stages at the beginning of the innovation process, because of the ever increasing complexity during further implementation.[5] They will therefore be willing to cover initial costs, but decide on terminating the innovation process at the later stages.
- Theory suggests that larger companies in general embrace an innovation strategy that builds on a portfolio of ideas, as to balance the overall economic risk of the required investments. At the later stages, when the set of ideas is further minimized, this balance might get upset. This could result in the termination of remaining individual innovation processes.
- Analysis within the framework of the mKETs pilot line project suggests that large and enlisted companies have an explicit research strategy with corresponding investment targets. It is suggested that for some of these companies this research strategy is unlinked to investment decisions further in the innovation process. This implies that initial investment in innovation is ensured. Further investments in later stages are based on a different decision process such as described above.
- Analysis within the framework of the mKETs pilot line project furthermore suggests that in general the innovation process is considered as a series of sequential stages, each addressed by dedicated (isolated) investment decisions with a corresponding assessment of the specific economic risk. Firms are in general more willing to invest at the early stages of the innovation process, as the costs are relatively low, and the results are more easily, and widely applicable. At the later stages in the innovation process; costs rise, and especially negative results make the underlying research useless.

Willingness of a firm to invest

With the help of economic theory (i.e. micro-economic / decision theory), we further assess the investment decision concerning pilot production and demonstration.[6] We therefore adopt a model that captures what a firm is willing to invest at the stage of pilot production and demonstration, as a basis to assess the potential shortfall with what is actually needed to cover the associated costs.

[5] See Montalvo Corral, M. (2002), *Environmental Policy and Technological Innovation.* Edward Elgar Publishing.
[6] See for example De Heide, M.J.L. (2011), *R&D, Innovation and the Policy Mix,* Tnibergen Institute PhD. Thessis, Research Series - Erasmus Universiteit Rotterdam

The model we adopt is a drastic simplification of the actual appraisal process by the firm when deciding on investing. In practice it captures the generic behaviour of companies, and should not be interpreted as an exact decision strategy adopted by individual firms. We need however such a model that predicts the behaviour of companies, as a basis to get insight in the role of the government (and other actors providing financial support).

We subsequently model the investment decision at the stage of pilot production and demonstration as follows:

$$\pi^0 \leq \underbrace{(1-p)(\pi^+ - K)}_{pay-off\ success} + \underbrace{p(\pi^0 - K)}_{pay-off\ failure} \qquad (1)$$

with:

- p as the probability of failure of the (remaining) innovation process (i.e. pilot production and demonstration and beyond);
- π^0 as the current / initial profit of the firm (and note that this can be equal to zero in case of a new firm / start-up);
- π^+ as the foreseen net profit after succesfull completion of the (rest of the) innovation process (i.e. market introduction / expansion;
- and K as the remaining costs of the innovation process (i.e. investments required).

The most relevant simplification (i.e. assumption) we make refers to the uncertainties the firm faces when deciding about investing in pilot production and demonstration. We assume that the firm has, prior to the actual implementation, a clear view on what will be the outcome of the innovation process (as reflected on the impact it will have on the profit of the firm after successful completion of the project), as well as the probability of failure and the associated costs (see Box 4).

The term on the right of the inequality sign of (1) now represents the expected pay-off for the firm in case it decides to conduct the innovation project (i.e. the sum of the expected pay-off in case of success and failure of the innovation project). The firm will compare this with the initial profit (left side of the inequality sign) before deciding whether or not to get involved in pilot production and demonstration.[7]

If we reformulate our representation of the investment decision of a firm according to (1), we get the following inequality:

$$\underbrace{(1-p)}_{\substack{probability\\ of\ success}} \underbrace{(\pi^+ - \pi^0)}_{\substack{net\ gain\\ in\ profit}} \geq \underbrace{K}_{cost} \qquad (2)$$

[7] See Wakker, P.P. (2010). Prospect theory: for risk and ambiguity. Cambridge University We assume that the firm is 'rational' (in economic terms, in that it opts for the highest pay-off). We furthermore assume that the firm will also implement the innovation process in case the expected pay-off associated with implementing the innovation project equals the initial profit. We argue that conducting the innovation project in that case will create a competitive advantage that in the longer run will result in a more dominant market position for the firm.

The model implies that we assume that a firm will decide on investing in pilot production and demonstration activities, based on his perception of the probability of failure, impact on the profit and required investments for the remaining innovation process. The model subsequently indicates that the a firm will initiate such activities if and only if the expected net gain in profit resulting from successful completion of the innovation process exceeds the associated remaining costs.[8] In any other case, "the economic risk is considered to be too high".

Box 4: Assumptions concerning the investment decision of firms concerning R&D&I

We model the investment decision as a "decision under risk" with (i) a predefined, and (ii) linear perception of, probability of failure, investment requirement and impact on profit. We argue that the former assumption (i) holds, as in practice many firms will make an assessment of the above-mentioned underlying decision factors, and interpret them as a basis for the investment decision (e.g. a "worst case scenario"). With the latter assumption (ii), we simplify the investment decision as an "optimal strategy" for the firm. In practice, the interpretation of the uncertainties concerning the decision factors is defined by the specific characteristics of the decision makers (e.g. loss aversion, perception of probability). The higher the level of uncertainty, the more important also other issues become in the decision process (e.g. relevance of the innovation process for the competitiveness / survival of the firm).

Note that the uncertainties associated with pilot production and demonstration can even be such that the firm cannot make a rational investment decision. This implies that the investment decision of the firm cannot be modelled. But more important, it implies that in practice the firm will not pursue the innovation process, because it will argue also in this case that "the economic risks are too high".

Rationale for public intervention

Figure 3 provides a graphic representation of equation (2), with the red line indicating what a firm would be willing to invest, given the probability of failure and the impact on the firm. The figure indicates that the characteristics of the innovation process indeed could be such that there is a "financing gap" between costs and potential investment (i.e. for p>p* in our figure).

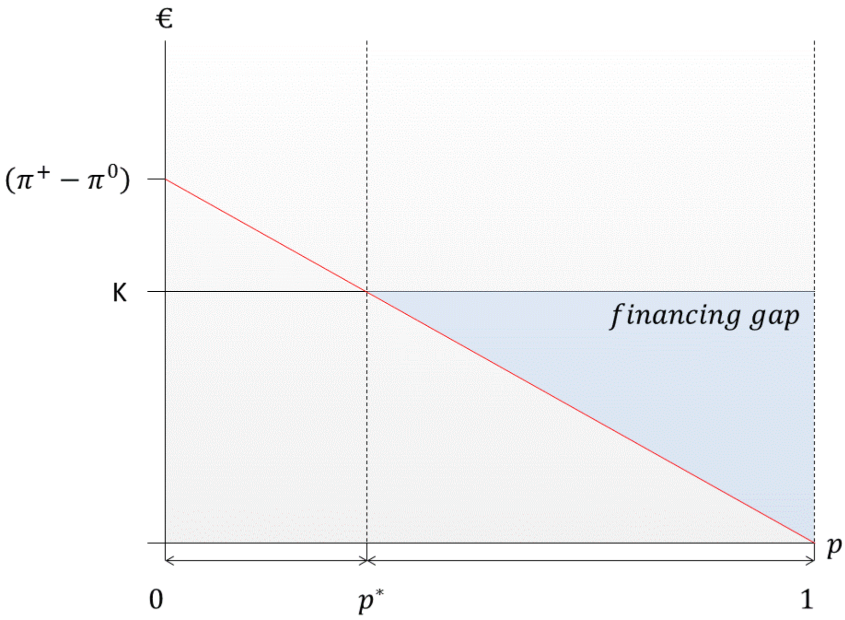

Figure 3: Willingness of a firm to invest

[8] The net profit equals total profit without the investment.

We subsequently argue that if a firm is not willing to conduct a pilot production and demonstration activity because it assumes that "the economic risk is considered to be too high", a government could consider intervening. Our model suggests three modalities of intervention to address the financing gap: [9]

- A government could intervene by addressing the *costs* of the innovation project, for example by providing subsidies, conditional loans (i.e. debt financing that has to be repaid only in case of successful completion of the project) or grants (such that K decreases).
- A government could also try to address the *probability of success* of the innovation project (such that the amount a firm would be willing to invest increases). This can be done in general by maintaining / sustaining a high knowledge capacity of the innovation system, including LLL.
- A government could also address the *net gain in profit* resulting from successful completion of the innovation project (such that the amount a firm would be willing to invest increases). This could be done by means of tax measures, but also by means of IPR and standards. A government could also try to create market demand for certain products by regulatory measures (e.g. for electric vehicles by improving the charging infrastructure, tax subsidies etc.) Intervention refers to strengthening the position of the innovative firm on the market.

Box 5: Effectiveness and efficiency of public funding

The section on the rationale for public intervention clearly indicates the essential role of the government in addressing the financing gap. But it also demonstrates the trade-off between effectiveness and efficiency of intervention that makes public financial support for pilot production and demonstration activities the subject of (political) discussion. An increase in the general aid intensity of financial support increases the effectiveness of intervention (i.e. initiates more innovation). But the efficiency of the corresponding resources decreases (i.e. the probability that innovation could have been initiated with less funding grows).

Based on the above we also argue that in practice an optimal intervention (i.e. that is effective and efficient) is not feasible because of information asymmetry between the firm and the government (and because it would be impossible to deliver optimal policy support that addresses the specific financing gap of individual innovation processes). Additional funding that exceeds the financing gap should therefore be considered as an innovation premium. But it should be noted that funding LSIs in practice seems more effective and efficient for governments to support R&D&I in comparison to supporting individual firms. LSIs offer costly research infrastructure and capacity, that can be used for different projects.

Note that the effectiveness of public support for pilot production and demonstration activities could be further increased if the government would address the uncertainties concerning the factors that define the investment decision of firms (i.e. impact, probability of failure and costs). The legal framework that governs public support for innovation (i.e. the State Aid rules) allows for this, although the underlying rationale (i.e. theory on market failure) is less explicit on this (see next section).

An LSI is an effective and efficient measure to initiate further innovation as it addresses the cost of the research, by providing shared research capacity (human capital and infrastructure) that a single firm is not able to maintain on its own. The availability of specific knowledge and experience in an LSI also increases the probability of success of the innovation process. It could even be argued that the

[9] Note that a condition for intervention would be an increase in total surplus, given the cost of the intervention.

presence of actors from the value chain provide the innovating firm with further insight on the potential impact of the R&D&I process.

Rationale for government intervention towards supporting the set-up / continuation of an LSI would be different types of market failure that create or deepen the "financing gap", or result in a problems concerning the financing of what a firm would be willing to invest, based on the characteristics of the pilot production and demonstration stage (see the next section for further elaboration of corresponding legal framework governing such intervention).[10]

Market failure and the State Aid rules

Interventions addressing pilot production and demonstration are governed by the State Aid rules on R&D&I.[11] These define a framework of conditions for support the intervention should adhere to in order to be eligible. The most relevant condition for our report refers to the fact that support should address market failure.[12]

The State Aid rules on R&D&I cite the following different types of specific market imperfections, that also affect the set-up of LSIs:

- *Positive externalities/knowledge spill-overs*: "R&D&I often generates benefits for society in the form of knowledge spill-overs. However, left to the market, a number of projects may have an unattractive rate of return from a private perspective, even though the projects would be beneficial for society because profit seeking undertakings neglect the external effects of their actions when deciding how much R&D&I they should undertake. Consequently, projects in the common interest may not be pursued unless the government intervenes." This also holds for R&D&I executed within the framework of pilot production and demonstration.

- *Public good/knowledge spill-overs*: "For the creation of general knowledge, like fundamental research, it is impossible to prevent others from using the knowledge (public good), whereas more specific knowledge related to production can be protected, for example through patents allowing the inventor a higher return on their invention. To find the appropriate policy to support R&D&I, it is important to distinguish between creation of general knowledge and knowledge that can be protected. Undertakings tend to free ride on the general knowledge created by others, which makes undertakings unwilling to create the knowledge themselves. In fact, the market may not only be inefficient but completely absent. If more general knowledge was produced, the whole society could benefit from the

[10] Note however that in practice especially smaller firms have problems with raising the financial resources to cover what they would be willing to invest, because of for example liquidity problems. This does impede the further implementation of the innovation process. In order to address the abovementioned liquidity problems, a government could address the risks for financiers, for example by means of a guarantee.

[11] See EC (2014) Framework for state aid for research and development and innovation COM (2014) 3282.

[12] In a market economy, an efficient allocation of production goods and services is not always a given. Market failure occurs when such an efficient distribution is not established (i.e. not Pareto optimal: there exists another conceivable allocation where an individual may be made better-off without making someone else worse-off). An inefficient allocation resulting from market failure leads to a loss in welfare. Market failure as such is therefore regarded as a rationale for intervention. Specific forms of the market failures result in suboptimal levels of investments in R&D&I. Underinvestment occurs when the incentives for private actors in the economy to allocate budget (i.e. financial resources) to research and innovation do not result in the socially optimal level of expenditure. Market failure as such is a rationale for policy intervention aimed at strengthening the innovation system.

knowledge spill-overs throughout the economy. For this purpose, governments may have to support the creation of knowledge by undertakings. In the case of fundamental research, they may have to pay fully for companies' efforts to conduct fundamental research." Pilot line activities generate knowledge that cannot always be protected completely against use by others (e.g. knowledge that addresses the abovementioned uncertainties in production). The subsequent spill-over effects limits the willingness of firms to invest in pilot production and demonstration.

- *Imperfect and asymmetric information*: "R&D&I are characterized by a high degree of risk and uncertainty. Due to imperfect and/or asymmetric information, private investors may be reluctant to finance valuable projects; highly-qualified personnel may be unaware of recruitment possibilities in innovative undertakings. As a result, the allocation of human resources and financial resources may not be adequate in these markets and valuable projects for the economy may not be carried out." This hold especially for the debt financing of pilot line activities.

- *Coordination and network failures*. "The ability of undertakings to coordinate with each other or at least interact, and thus deliver R&D&I may be impaired. Problems may arise for various reasons, including difficulties in coordinating R&D and finding adequate partners." In the case of LSIs, the foreseen benefits of pilot production and demonstration for individual firms to not cover the costs for the associated facilities. Shared facilities subsequently do not emerge because it is difficult for different firms to formulate a joint and articulated demand for such a PPS.

In literature also other forms of market failure associated with R&D&I are identified. The most relevant form with respect to the set-up of LSIs refers to *market power*. This occurs when firms are in the position to show 'strategic behaviour', such as the creation of excess capacity, 'limit pricing', or collusion as to limit access to a specific market by other companies.[13] Market power can subsequently hinder innovation and imitation, as it raises barriers for entry of innovative start-ups: (1) innovation projects require large risk-intensive investments that cannot be covered by small firms; (2) complex innovation projects require access to external knowledge, which cannot be obtained by small firms because of the associated high fixed cost; (3) implementation of certain innovation requires that firms obtain permits or licenses, which can be difficult for small firms to cover because of the associated cost.

Box 6: Notifying public intervention for R&D&I.

The State Aid Rules stipulate that public (financial) intervention addressing R&D&I must be notified, as to assess whether the: "[…] measure can be considered compatible with the internal market." The European Commission (DG Competition) therefore analyses " […] whether the design of the aid measure ensures that the positive impact of the aid towards an objective of common interest exceeds its potential negative effects on trade and competition." The (design of the) intervention therefore has to pass a so-called balancing test. Most relevant in this respect is that the occurrence of a form of market failure has to be demonstrated. This can be done by reference to econometrics (where sufficient data are available) or by the use of benchmarking analysis. Having satisfied itself as to the existence of a market failure, the Commission assesses the compatibility with the remaining conditions.

[13] Factors contributing to gaining market power are: a lack of transparency in the market, cost associated with conversion to a competing product or service endured by consumers, natural monopolies, and 'sunk cost' resulting for example from building up a market position (i.e. reputation).

Note that uncertainty as such (as introduced in the previous section) cannot be addressed by financial support, as it is not considered a type of marker failure. The State Aid rules however allow for the support of a 'feasibility study', involving “[…] the evaluation and analysis of the potential of a project, which aims at supporting the process of decision making by objectively and rationally uncovering its strengths and weaknesses, opportunities and threats, as well as identifying the resources required to carry it through and ultimately its prospects for success.” Support for such an activity, also within the framework of pilot production and demonstration, does address the subsequent investment decision of the firm. But it also allows for more efficient public financial support of pilot line projects.

Financing of the LSI’s operations

Our analysis within the framework of EU-GREAT! confirms that the funding needs resulting from setting up and running PPPs such as LSIs are considerable, and exceed the other overall costs of individual innovation projects.[14] Within the framework of LSIs, different activities are subsequently implemented to address these costs, that generate immediate revenues, but also indirect forms of income (e.g. licence fees for IPR generated, participations in spin-offs, etc.). These activities support the specific objectives of LSIs as observed within the framework of the EU-GREAT! project, such as: i) provide easy access to state-of-the-art equipment and expertise; ii) develop and strengthen ecosystems; iii) address skills needs; iv) provide a platform for networking; v) facilitate business development (e.g. supporting start-ups); vi) facilitate knowledge exchange.

This chapter further describes financing needs and revenues generated by LSIs within the framework of a multi-annual operating budget, and how these meet.

Financing needs of an LSI

Prior research suggests that the costs associated to setting-up and running an entity like an LSI can be clustered according to four categories: i) start-up costs; ii) infrastructure costs; iii) project costs; and iv) all other costs / operational costs.[15] These elements correspond to the items of the financial plan that constitutes the manual for the business and investment plan that is part of Deliverable 5.4 as well as the interactive website of the EU-GREAT! project.

Start-up costs

Start-up costs arise in the first stages of the set-up of the LSI. The start-up phase is considered to be finished as soon as the first projects are being conducted.[16] Subsequent costs result from:

- Consortium building (e.g. meetings between possible partners)

[14] This section builds on De Heide, M.J.L., M. Butter and L. Seiffert (2016), *The financing of fieldlabs in the Netherlands*, TNO 2016 R11435. The analysis and the corresponding report refer to the financing of so-called fieldlabs within the Dutch context. Fieldlabs are defined as “practical environments in which companies and knowledge institutions develop, test and implement Smart Industry solutions”. A key component of fieldlabs is that they offer equipment which can be used by multiple parties. The overall goal of fieldlabs is to create economic and social benefits by spurring innovation. As such they are comparable to LSIs.

[15] It should be noted that this clustering was recognised by representatives from the PPPs under review. In practice however (i.e. in the every-day management of a LSI) this typology was not adopted, for example because it is difficult to link it to revenues.

[16] Within the Dutch context the costs for start-up usually ranges between 250.000 euro and one million euro (see De Heide, M.J.L., M. Butter and L. Seiffert (2016), *The financing of fieldlabs in the Netherlands*, TNO 2016 R11435).

- Market analysis (e.g. meetings with potential clients, costs for professional market surveys)
- Developing a business plan or proposal for funding (e.g. writing a proposal to apply for subsidies)
- Developing the work programme and strategic research agenda of the LSIs

The financing in the start-up phase can roughly be divided into two stages. During the first 'exploration' phase a number of parties explore together the possibility to set up a LSI. This phase is characterised by informal talks, some background research and sometimes stakeholder workshops.[17] At the end of the exploration phase a 'go' or 'no-go' decision is taken on whether the idea of setting up a LSI is pursued or not. The second phase is characterised by the effort to develop a business plan/programme of work for the LSI and obtain funding for the envisaged activities.[18]

Infrastructure costs

Infrastructure costs arise with the purchasing of physical infrastructure, such as buildings or equipment.[19] The characteristics of the infrastructure define the role and relevance of the LSI within its specific innovation chain. The availability of costly infrastructure provides the rationale for the existence of LSIs. As indicated in the previous chapter, individual firms are in general not willing to cover the total investments required to purchase the equipment provided by the LSI, as the resulting benefits of their use are often not sufficient to cover the costs. By allowing the shared use of infrastructure, thereby limiting the individual costs for the firm, the decision concerning whether or not to get involved in innovation can be altered.

Project costs

Implementation of projects results in costs concerning for example salaries of research staff working on a specific project, costs for purchasing specific and dedicated equipment used for single project, costs for organizing a project-specific event, costs for project management, etc.[20] The total budget for conducting projects usually increases during the first years of a LSI, until a relatively steady state is reached after approximately five years.

Other / operational costs

Running a LSI also results in additional operational costs. They emerge from the day-to-day operation of a LSI (e.g. salaries for staff not working on a project-base such as business developers and management staff, rent for buildings, maintenance of infrastructure, operation of website,

[17] Within the Dutch context, resources devoted to this phase usually range between 30.000 to 50.000 euro (see De Heide, M.J.L., M. Butter and L. Seiffert (2016), *The financing of fieldlabs in the Netherlands*, TNO 2016 R11435).
[18] Within the Dutch context, the costs for this second phase of the start-up process can differ widely, from 200.000 euro to up to 1 million euro (see De Heide, M.J.L., M. Butter and L. Seiffert (2016), *The financing of fieldlabs in the Netherlands*, TNO 2016 R11435).
[19] Within the Dutch context, amounts of up to 100 million euro were observed (see De Heide, M.J.L., M. Butter and L. Seiffert (2016), *The financing of fieldlabs in the Netherlands*, TNO 2016 R11435).
[20] Within the Dutch context, project costs in general account for roughly 80% of a LSI's annual budget (see De Heide, M.J.L., M. Butter and L. Seiffert (2016), *The financing of fieldlabs in the Netherlands*, TNO 2016 R11435).

organisation of regular networking events). They incur on a regular basis and are not related to specific projects.[21]

A large part of operational costs are related to acquisition and monitoring of projects. Many LSIs rely on multiple funding sources and hence have to deal with several different application and reporting cycles, each imposing different requirements.

Operation costs are high in the beginning, as LSIs have to build up a project portfolio. Later on, once the LSI has established its reputation and network, operational costs become a function of project costs (i.e. operational costs will increase and decrease with the number of projects a LSI is conducting).

Sources of income

Analysis within the framework of EU-GREAT reveals that LSIs offer different kinds of activities, that can be generalised according to the entries in Table 1, that generate a certain revenue. Note that these activities can also result in indirect sources of income (e.g. licence fees from IPR generated). These activities correspond to the items of the financial plan that constitutes the manual for the business and investment plan that is part of Deliverable 5.4 as well as the interactive website of the EU-GREAT! project.

Our analysis suggests that most of the revenues generated by a LSI originate from publically co-funded single / dedicated shared R&D&I projects. The contributions of the different actors to these kind of projects is very different in nature (and can also be in-kind), and reflect the role of the corresponding actor in the PPP. Note that ownership of the results of publically co-funded R&D&I of projects is non-exclusive, meaning that outputs (e.g. IP / new technologies) can be used by all parties partnering in the project / programme). This has an impact on the decision of firms concerning participating in such a project (see previous chapter).

For some of the LSIs that have been reviewed, these abovementioned projects result from co-funded shared work-programmes or roadmaps that have been set-up by the LSIs in collaboration with the actors of the PPP (e.g. industry, and universities / RTOs). These programmes are (pre)-financed by the participating actors in the LSI for multiple years. The contribution by the industrial partners can be considered as a membership or participation fee. Public support as well as the contribution by the participating RTOs and universities can be considered as a form of basic funding for the LSI.

Previously mentioned prior research suggests that LSIs also carry out contract research on behalf of industrial partners. In contrast to co-funded R&D projects, the intellectual property (IP) generated in contract research projects is usually exclusive, meaning that companies obtain the exclusive right to use the results or even obtain total ownership of the IP. LSIs also offer for example commercial services, such as lab services, testing and validation services. In some examples, the LSIs also rent out equipment to firms, such that these can use it to advance their own technology.

[21] Within the Dutch context, operational costs usually amount to 10% to 20% of a LSIs total annual budget (see De Heide, M.J.L., M. Butter and L. Seiffert (2016), *The financing of fieldlabs in the Netherlands*, TNO 2016 R11435).

Activities and other sources of income	Actors involved		
	Business	Universities / RTOs	Government ((supra)nat. / reg. / local)
Co-funded collaborative R&D&I projects	(part of the) project costs (also in-kind)	(in-kind) project contribution	project funding
Co-funded R&D&I programmes / roadmaps with corresponding projects	participation fees (also in-kind)	(in-kind) contribution as basic funding for the LSI	basic funding
Contract research	project costs		
Initial series production / testing in labs / micro-production	project costs		
Infrastructure use	project costs		
Consultancy and services (workshops, training and education, scouting and intelligence, incubator services, …)	consultancy fee		
Public procurement of R&D&I			project costs
IPR	licence fees		
Participations	revenues		

Table 1: Activities as a source for generating income, by actor in the PPP.

The LSIs under review in the EU-GREAT! project are exploring also other sources of income, such as consultancy and services (workshops, training and education, scouting and intelligence, incubator services), public procurement,[22] licensing out IPR, or pay-offs generated by participations in spin-offs or start-ups originating from for example R&D&I projects conducted.

Costs versus revenues

In this section we assess how the costs of an LSI develop over time, and how these are addressed by income of the LSI, resulting from the delivery of activities for the stakeholders involved in the PPP. These elements form the basis for the multi-annual operating budget of a LSI.[23] We emphasize the role of private contribution to the financing of the LSI in our analysis, as this is considered an important indicator of the relevance and success of the PPP.[24]

[22] Public procurement of R&D&I is a specific type of contract research, involving the purchase of goods and services by or on behalf of a public authority, such as a ministry or government agency. Public procurement is in most western countries regulated (e.g. public tenders must be issued if the value of the contract exceeds a certain threshold) as to prevent infringement of the State Aid rules (i.e. to prevent abuse such as local protectionism).
[23] As an example of such a multi-annual budget, see the outline for the financial plan of an LSI on the EU-GREAT! interactive website www.eu-great.com.
[24] This section builds on De Heide, M.J.L., M. Butter and L. Seiffert (2016), The financing of fieldlabs in the Netherlands, TNO 2016 R11435.

Figure 4: Financing of the operations of an LSI

Start-up

Our analysis within the framework of EU-GREAT! confirms that the costs resulting from the start-up phase of a LSI are almost always covered by public research organisations such as RTOs or universities. Companies are reluctant to invest at this stage because of the uncertainty with respect to whether the LSI will generate enough benefits to offset initial investments. Especially in case the LSI addresses what is defined as "Science for Science" or "Science for Society", the actors involved in PPP assume that universities or RTOs will finance the initial stage.

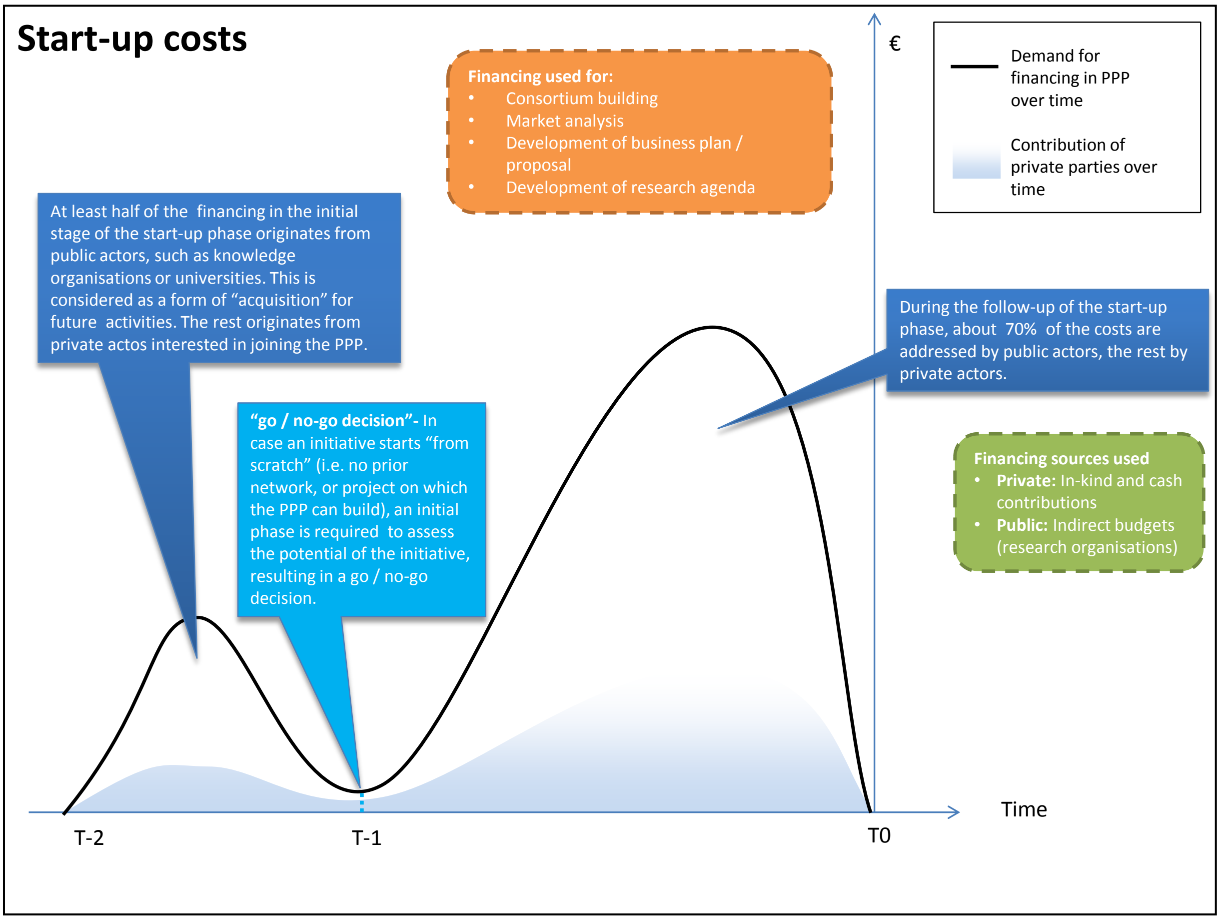

Figure 5: Costs associated with the start-up of LSIs (Source: De Heide et al. (2016))

Universities and RTOs consider the investments required to cover the costs that emerge during the start-up phase as a form of expenditure associated to the acquisition of new income. They anticipate on revenues from for example future contract research or other consultancy services to be conducted once the LSI is running to cover these required investments.

These acquisition costs at the start-up phase in general cannot be covered with EU funded programmes, or by any regular / existing public funding scheme or institutionalised instrument in many EU countries.

Infrastructure

The investments required to cover the costs for infrastructure are in general relatively high. Our analysis within the framework of EU-GREAT! suggest that LSIs try to cover the costs for acquisition and updating of the essential but costly infrastructure by means of the revenues created by LSI, such as participation fees and contributions to collaborative research projects, and co-funding.

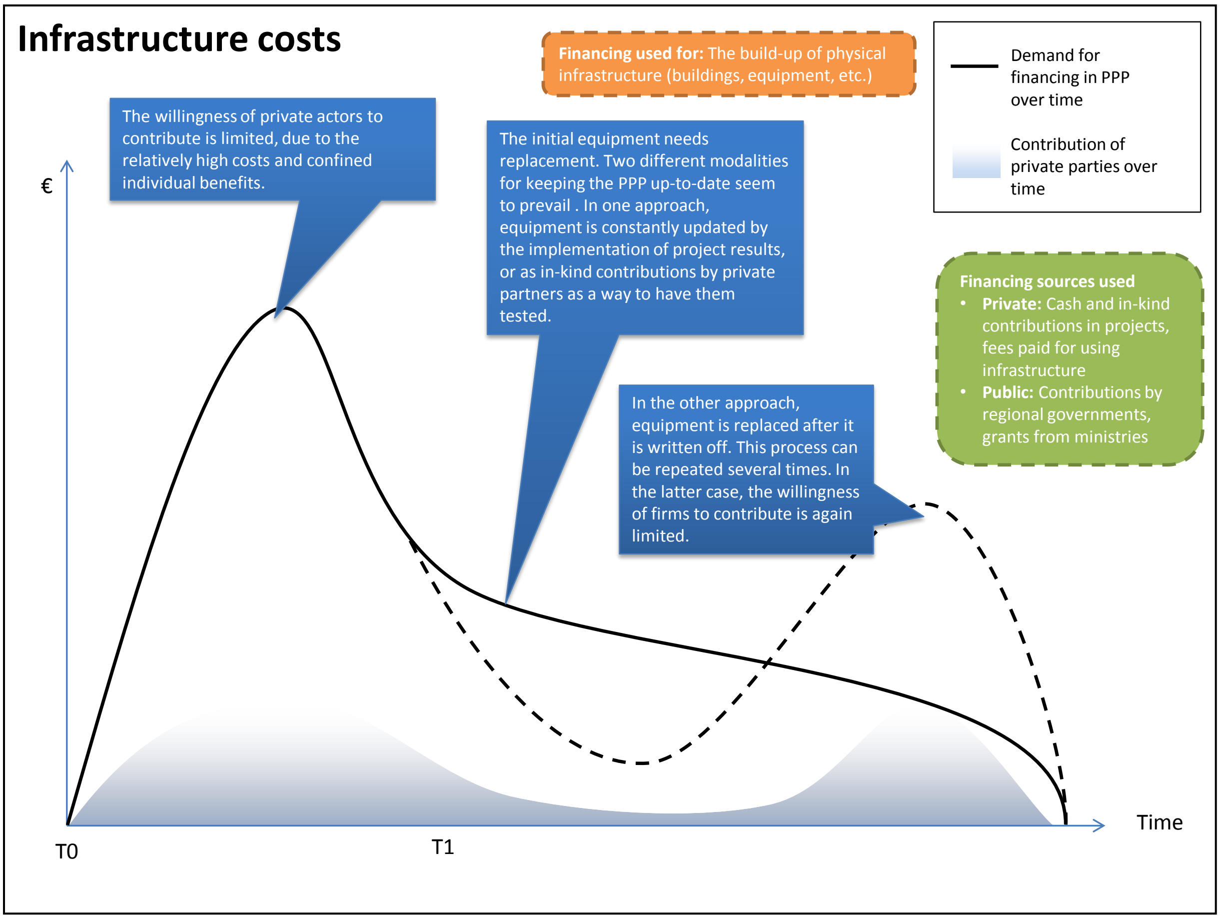

Figure 6: Costs associated with the purchase and replacement of infrastructure (Source: De Heide et al. (2016))

Our analysis confirms that there are two important issues that limit the use of these forms of revenue as a basis to cover the required investments:

- Equipment is an essential element (condition) for LSIs to actually generate revenues. In practice there is an immediate financing gap in the multi-annual (operating) budget at the very start of the LSI initiative that is difficult to address. Firms are not willing to get financially involved at that stage if the LSI does not yet have a certain reputation (i.e. with respect to the quality of the output / results). There is furthermore also no specific / dedicated public instrument that addresses the pre-financing of equipment during the build-up of a LSI.

- Revenues in general seem not sufficient to cover the purchase of equipment. In many of the analysed LSIs there is subsequently a structural gap in the multi-annual (operating) budget of the LSI.

Projects

According to our analysis, almost all activities offered by LSIs as a way to generate revenues are implemented in the form of projects. There is a wide variety of sources used to directly cover the costs resulting from conducting these projects within the framework of LSIs (see Table 1). The corresponding modalities of financing include amongst others: cash and in-kind contributions by private parties; organisational funding of knowledge organisations, regional, national and European funding (e.g. Interreg Europe, EFRD, Horizon2020, CEF, etc.), and contributions of universities (e.g. secondment of PhD students to do research in LSIs).

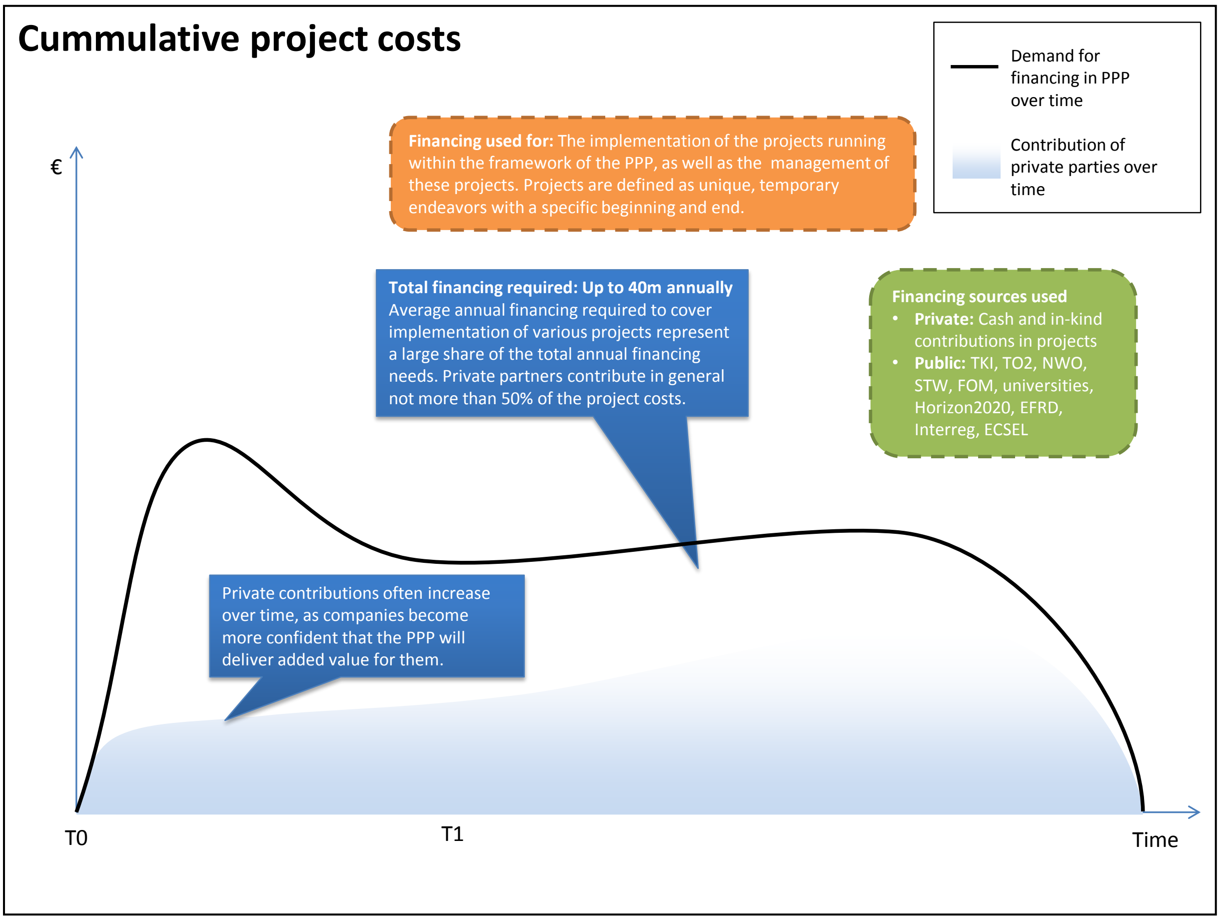

Figure 7: Project costs (Source: De Heide et al. (2016))

Funding for collaborative research projects by private parties does not start immediately once a LSI is set up. This suggests a potential immediate financing gap in the first years after the start-up of the LSI.

The level of private contribution to funding of projects depends on a variety factors; the most important ones being:

- *Stage in lifecycle:* LSIs that have just started generally find it challenging to obtain private funding, as they first have to "prove themselves". Once they can illustrate their added value by referring to concrete projects they carried out in the past, companies are less reluctant to contribute to projects.
- *Position in the innovation chain:* LSIs that focus on lower TRLs generally receive less private funding than LSIs that address higher TRLs. Investing in high-TRL projects is more attractive for companies as the projects' results are already closer to the market. Projects focusing on technological research are less interesting for companies, as their results cannot as easily be transferred into a marketable product or service.
- *Sector structure:* A major challenge for financing projects is that companies generally favour in-kind over cash contributions. In contrast, fieldlabs tend to favour cash contributions. In sectors with a high share of SMEs, or in sectors in which companies tend to have less cash freely available, obtaining cash contributions for projects can be very difficult.
- *Type of research addressed:* The willingness of firms to invest in R&D&I project that run in an LSI is defined (amongst others) by the potential impact on profit (see previous chapter). We therefore argue that the willingness of firms to get involved in R&D&I projects is higher for what is defined as "Science for Competitiveness" in comparison to "Science for Science" and "Science for Society".

As indicated, public funding for collaborative research projects (resulting from dedicated programmes, as well as specific co-funded collaborative R&D&I projects) is essential. Especially relatively low-TRL activities, such as R&D, concept validation and prototyping, are often publicly funded. Governments have traditionally been more reluctant to fund activities on higher TRL levels, such as pilot production. However, due to international competition, there is a recent trend in European and national policies to allow for public funding of pilot production activities as well.

For example, the High Level Group on Key Enabling Technologies recommended launching multi-national large scale funding initiatives in strategic industrial domains like Connected & Automated Driving or microelectronics[25]. As a suitable funding instrument the High Level Group emphasized an "Important Project of Common European Interest" (IPCEI), an option given in the EU treaties. The European Commission highlighted the importance of this new funding instrument and gives guidance on the implementation of IPCEI.[26] In short, an IPCEI is a state-aid instrument to facilitate public funding at an unprecedented level for all related activities (incl. CAPEX). It can go beyond any existing European or national funding scheme in scope, objective, and budget.

Other / operational costs

Prior research suggests that for PPPs such as LSIs that private contribution to the financing of operational costs differs, and cannot be generalised. Companies seem reluctant to fund operational

[25] High Level Expert Group on Key Enabling Technologies, Final Report, Time to Act, June 2015
[26] Criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of important projects of common European interest, European Commission (2014/C 188/02)

costs, as their interest in operational activities (e.g. management, networking events, information dissemination) is not immediate. This suggests a potential structural financing gap for the LSI.

The analysis furthermore suggests that LSIs have developed different models to cover operational costs. One practice is to cross-charge operational costs to projects, meaning that the over-head costs are part of the hourly rates of research staff working in the LSI. Another practice is to finance operation costs through annual participation fees that partners that are involved in the LSI have to pay. In many LSIs both of the practices are used. Many public funding sources allow that a certain percentage of the funding (e.g. 5% or 10%) can be used to cover over-head costs.

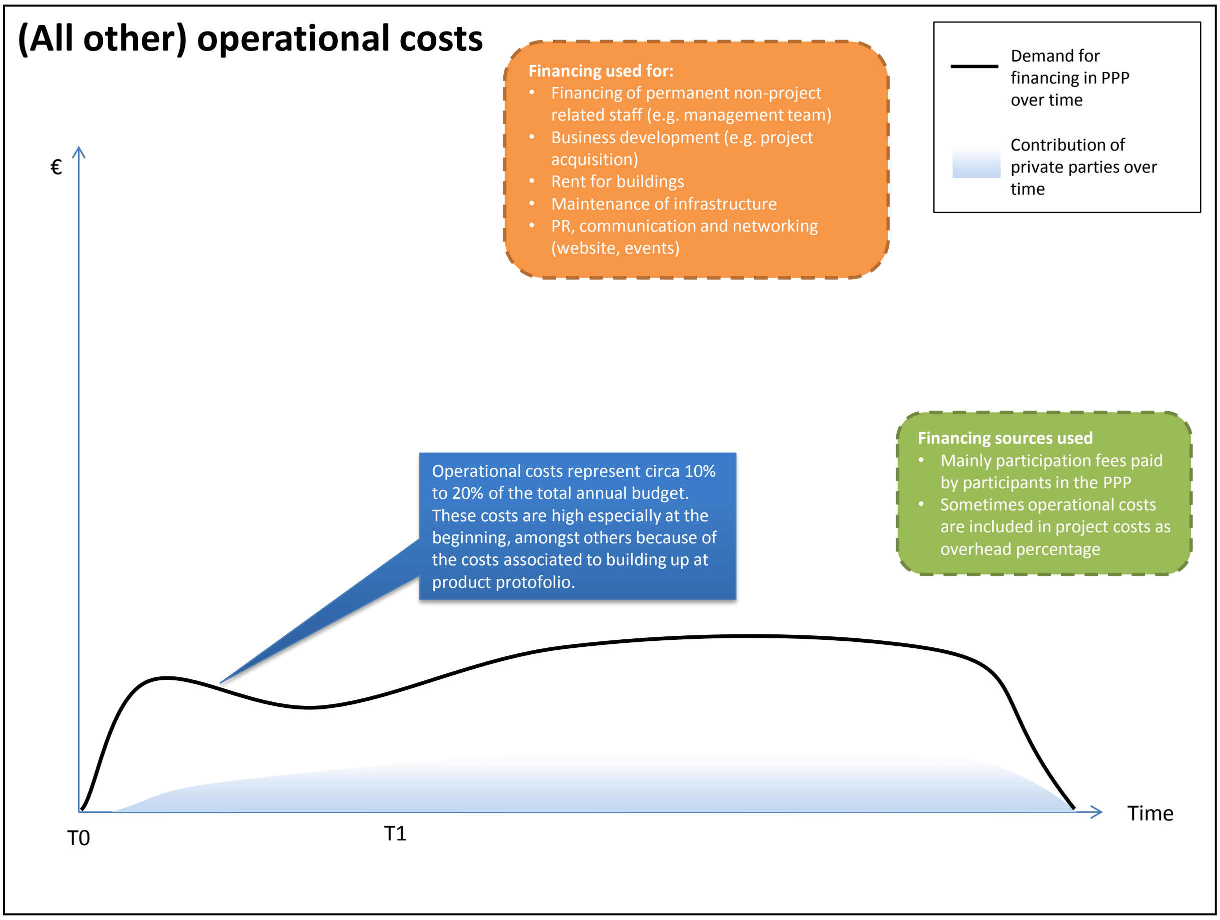

Figure 8: Other / operational costs (Source: De Heide et al. (2016))

Investments

According to our analysis of the previous chapter, LSIs are very often faced with a gap in their multi-annual (operating) budget. As indicated, we distinguish between two different forms of budget deficit:

- A structural gap arises when the overall budget suggests a shortage in income over costs of the LSI over the combined years of the multi-annual budget. It implies that the LSI is not able to reach break-even. Note that this is in practice not surprising given the underlying forms of market failure (notably coordination failures , see Appendix A) that prevent the emergence of LSIs without structural intervention (i.e. support) by a government.

- An immediate gap arises when investments required to initiate (or continue) the LSI cannot be pre-financed, because revenues are not yet generated. This is an issue, as already illustrated, especially with respect to the financing of equipment and human research capacity for projects.

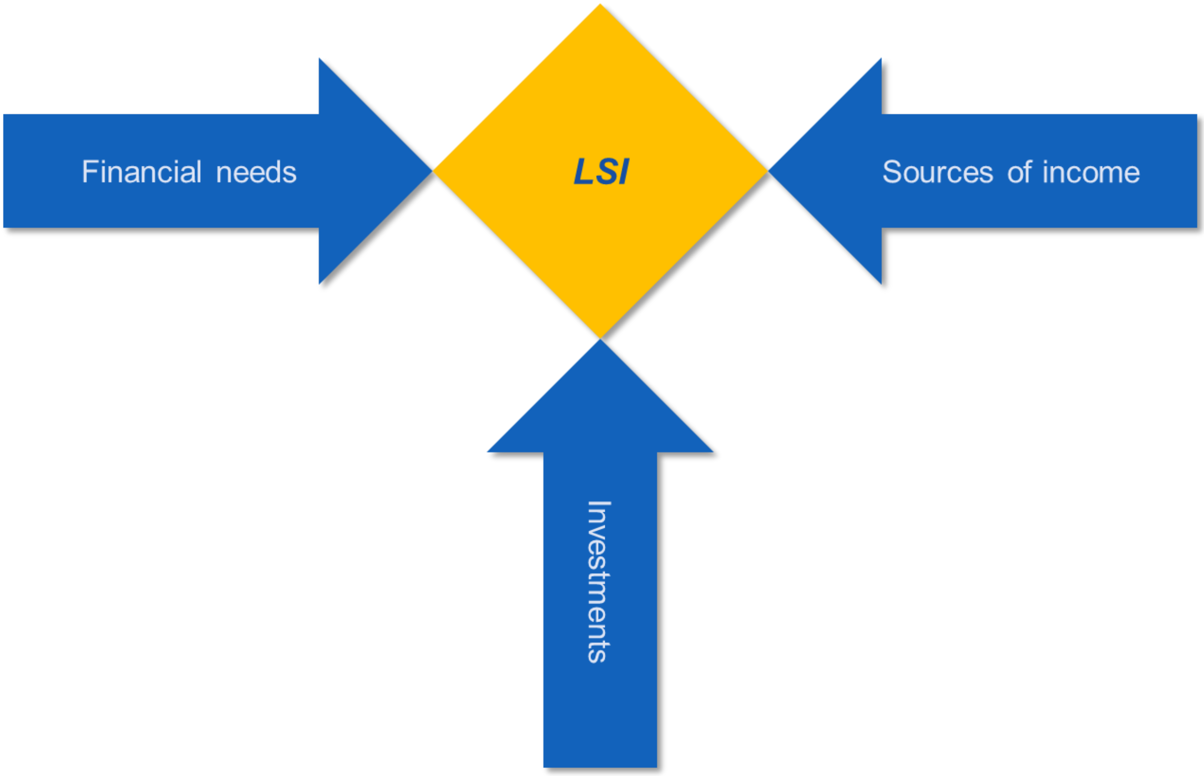

Figure 9: Investments addressing the financing gap of LSIs

In this section we will describe the potential investments that can address the gap between costs and revenues. Note that again these suggested investments correspond to the items of the financial plan that constitutes the manual for the business and investment plan that is part of Deliverable 5.4 as well as the interactive website of the EU-GREAT! project.

Investments addressing the structural financing gap

Because of their role in the innovation system, many LSIs are confronted with a structural gap between revenues and costs. Especially in case of what is defined as “Science for Science” and “Science for Society”, financial involvement of industry is not evident, and with that income therefore does not always cover the investments required for the costly research infrastructure that defines the functioning of the LSI for example.

Government intervention is essential in order to close this structural financing gap. Successful examples of LSIs thereby suggest an ad-hoc approach towards additional funding, in which different instruments originating from different sources (EU, national as well as regional) are combined.[27] A wider interpretation of the rules governing the different instruments (e.g. on eligibility, reporting, etc.) seems to be a precondition, as to allow combined funding.

[27] See De Heide, M.J.L., M. Butter and L. Seiffert (2016). *The financing of fieldlabs in the Netherlands.* TNO 2016 R11435.

Regional public actors have a different objective in providing additional financing. They are in general not only driven by policy objectives aiming at supporting knowledge creation because of various underlying forms of market failure, as research results in general spills over to a supra-regional level. By providing financial support, regional policymakers hope to anchor the LSI in the region in order to ensure that other positive externalities of the LSI (e.g. job creation, eco-system building, creation of new start-ups, etc.) can be reaped in the region.

Note that the abovementioned examples of government intervention are characterised by the fact that no *direct* research related activities (i.e. research project) result from this additional financial support. The funding mentioned here is as a precondition for the establishment of a LSI, such that the activities as mentioned in Table 1 can be conducted.

It should be mentioned that other studies (notably the mKETs pilot line study) suggest that companies sometimes contribute equipment as a form a sponsoring to a LSI.[28] Rationale for such a this type of support would be that a LSI provides an optimal environment for testing of such equipment.

	Actors involved		
	Business	**HE / PNP**	**Government (supra)nat. / reg. / local**
(Financial) support not linked to services, to address structural financing gap	in-kind / equipment (sponsoring)		additional funding (addressing societal challenges, employment, eco-system building, etc.)

Table 2: Investments addressing the structural financing gap of LSIs

Investments addressing immediate financing gap

	Actors involved			
	Business	**HE / PNP**	**Government (supra)national / regional / local**	**Other**
Debt financing, to address immediate financing needs	(subordinate) loan, guarantees	(subordinate) loan, guarantees	(subordinate) loan from a fund, guarantee	Banks, FFF, etc. (loans)
Equity financing	participation	participation	seed facility, participation	VC (skills and investments), Private equity (investments), Angels / Seed Capital (investments)

Table 3: Investments addressing the immediate financing gap of LSIs

Our analysis suggests that LSIs encounter problems with financing especially at the initial phase, or when trying to continue the initiative, when high investments are required to cover the purchase / renewal of costly equipment, or the involvement of human research capital. It seems especially difficult to align and match the potential financial commitment by the different actors in the PPP,

[28] See www.mkpl.eu.

specifically when the implementation / delivery of the specific activities of the LSI has not yet commenced, and revenues are not generated.

Policy makers are increasingly emphasising the potential role of non-conventional modalities of financing, and the involvement of corresponding (external) actors, to address immediate financing needs of LSIs. Suggestions include different forms of debt financing (commercial or otherwise) or equity financing (see Table 3).[29]

Recommendation 1

An important recommendation for further research would be to analyse who should be the first to indicate commitment concerning financing in order to address the immediate financing gap (i.e. which actor of the PPP and / or external financier), and why?

Rationale for emphasizing debt and equity financing is that the risks and financial implications in case of failure of the LSI do not lie with the government. It is furthermore argued that there are no forms of market failure that would legitimize a form of direct support (i.e. with the help of for example a subsidy that does not have to be reimbursed) to address an immediate financing gap. Note that there are limitations to the effectiveness of debt and equity financing as a means to initiate (or continue) a LSI, as these measures do not address the structural financing gap (see Box 7).

This section briefly introduces the relevant forms of debt and equity finance, as a basis for a discussion on how to combine these (with funding) in the next chapter.

Box 7: Effectiveness of debt and equity financing

In line with the micro-economic theory as introduced in the first chapter, we argue that an LSI (defined here as a legal entity that would be able to take a loan), would never take out a loan sum that would exceed its potential revenues (nor would it be given one). As such, traditional debt financing is not an effective instrument to address the structural financing gap.

Equity financiers seek for a certain return on their investment, implying that revenues should exceed costs. In line with the theory of the first chapter, we therefore also argue that equity financing is not an effective instrument to address the structural financing gap.

Debt finance

In case of debt financing, a loan is provided under the condition that this is returned at a later point in time, including interest payments. Interest rates are determined by the duration of the loan and the chance of default, macro-economic conditions, but also (internal) banking regulations.

Analysis within the framework of EU-GREAT! indicates that there are numerous public loans and government guarantees for loans available on EU, national and regional level for the financing of a LSI. The European Investment Bank as an example offers debt financing solutions for entities like LSIs to pre-finance equipment. In Member States different initiatives are being developed to deploy the EFSI as a mechanism to support entities like LSIs with debt financing.[30]

[29] Rationale for government intervention addressing debt financing are forms of market failure that limit the functioning of capital market for initiatives such as LSIs.

[30] EFSI is an initiative launched jointly by the EIB Group - European Investment Bank and European Investment Fund - and the European Commission to help overcome the current investment gap in the EU by mobilising private financing for strategic investments. EFSI is one of the three pillars of the Investment Plan for Europe that aims to revive investment in strategic projects around Europe to ensure that money reaches the real economy.

Also private loans could support LSIs in addressing the immediate financing gap. Commercial banks would seem the most obvious actors to provide debt financing, although different forms of market failure limit access of LSIs to the capital market.[31] Also other actors, such as the partners in the PPP, could provide a form of debt financing, under conditions (i.e. interest rate and time to return the debt) that they define themselves. [32]

Box 8: Additional forms of debt financing

Note that loans that only have to be paid if the project or activity that was funded was successful (in monetary terms) do alter the behaviour of the actors involved in the PPP, in that they would be willing to contribute more to the LSI.[33] As such, they would be able to address the structural financing gap. Funding with a revolving element could be considered as such a "conditional loan".

Next to regular loans, several forms of special loans exist.[34] Our analysis indicates however that these types of loans seem currently not considered widely for the financing LSIs.

- Subordinate loans are loans that have lower priority than other debts if a company falls into liquidation or bankruptcy. For example if the debtor goes bankrupt, all other creditors have to be paid first before the provider of the subordinate loan is paid out. Hence, subordinate loans are more risky for the lender than regular loans. Some governments provide subordinate loans to stimulate innovation, as they make it more attractive for private lenders, such as banks, to invest in innovation projects.

- Another difference that can be made is between secured and unsecured loans. A secured loan is a loan in which the borrower pledges some asset (e.g. machinery) as collateral for the loan. In case of default the creditor takes possession of the asset used as collateral and may sell it to regain some or all of the amount originally loaned to the borrower. In contrast an unsecured loan is not connected to any specific asset that the creditor has a right to in case of default. Hence, unsecured loans are riskier for the lender and therefore they usually have a higher interest rate.

- A way how the government can stimulate private lenders to provide loans for innovation projects is by offering government loan guarantees. In this case the government promises to assume a private debt obligation if the borrower defaults. A guarantee can be limited or unlimited, making the government liable for only a portion or all of the debt. With a guarantee a government addresses typical and well-known types of market failure associated with access to the capital market of actors involved in innovation.

Recommendation 2

An important recommendation for further research would be to analyse the potential of other forms of debt financing to address the immediate financing needs of LSIs.

[31] Notable information asymmetries, which make it difficult for a commercial bank to assess the risks involved.

[32] Note that public actors need to define the conditions within the constraints set in the State Aid rules. The basis for the actual assessment of the request for the loan (i.e. evaluation of potential failure and subsequent risks involved) and the subsequent decision on whether or not to provide debt financing should be similar for all public and private actors involved in debt financing for LSIs.

[33] See De Heide, M., & Kothiyal, A. (2011). *How to select Instruments supporting R&D and Innovation by Industry.* Tinbergen Institute Discussion Paper, TI 2011-021/2.

[34] See Tirole, J. (2006). *The Theory of Corporate Finance.* Princeton University Press.

Equity financing

When a LSI receives equity financing, it implies that it receives financing in exchange of (part of) the ownership of the entity. The equity financier subsequently earns the right to (part of) the potential profit. As such, equity financing could address the immediate financing gap.

Most relevant for the support of LSIs would seem to be private equity.[35] Two types of investors providing private equity can be distinguished: i) formal investors that have specialised in providing equity finance (e.g. investment firms, regional development agencies); and ii) informal investors, also called business angels, which are mostly private person that invest in companies on an individual basis and are sometimes organised in 'business angels' networks.

Most often mentioned as potential investors in LSIs are Venture Capitalists. VCs tend to get involved in what they define as prospects that are still in the early stages of their lifetime, and that have a potential to grow. Financing by VCs is attractive for new companies with limited operating history that are too small to raise capital in the public markets and have not reached the point where they are able to secure a bank loan (or complete a debt offering). VCs not only invest in a prospect, they also provide additional skills and knowledge. They often focus on specific sectors, where they have extensive knowledge about the market. This insight allows them to better assess the potential of a specific prospect.

Our analysis did not reveal any involvement of equity financiers in LSIs. In the following chapter, we will assess the potential relevance of equity financing for LSIs.

Conclusions and recommendations concerning (combined) financing of LSIs

In this chapter we first assess the ratio between public funding and private financing generally observed within LSIs, and the legal framework that governs intensities of public support. We subsequently analyse key bottlenecks in public financing for LSIs. Last we assess issues with obtaining debt and equity financing by LSIs. As such, we obtain insight in the problems with (combined) financing of LSIs. We subsequently formulate policy recommendations addressing these problems.

Level of public funding and private financing for LSIs

Prior research suggests that the annual budget of PPPs like LSIs averages at circa 25 million per year.[36] The ratio between private and public financing of the budget differs significantly, but in general private contribution does not exceed public support. The ratio seems defined primarily by the characteristics of the LSI, such as for example the type of research conducted within the PPP.

Public support is governed by the State Aid rules on R&D&I. These define PPPs such as LSIs and their corresponding activities as a form of industrial research or experimental development (depending on the exact characteristics of the R&D&I, see Box 10).

[35] Public equity (i.e. equity in the form of shares of stock which are freely traded on a stock exchange) seems less relevant for LSIs, especially in order to address the immediate financing gap that arises at the start-up phase.
[36] See De Heide, M.J.L., M. Butter and L. Seiffert (2016). *The financing of fieldlabs in the Netherlands.*

Box 9: State Aid rules concerning combining of funding

The State Aid rules on R&D&I state that:

1. Union funding centrally managed by the institutions, agencies, joint undertakings or other bodies of the Union that is not directly or indirectly under the control of Member States does not constitute state aid. Where such Union funding is combined with state aid, only the latter will be considered for determining whether notification thresholds and maximum aid intensities are respected or, in the context of this framework, subject to a compatibility assessment.
2. In the case of state aid for a project being carried out in collaboration between research organisations and undertakings, the combination of direct public support and, where they constitute aid, contributions from research organisations to the same project must not exceed the applicable aid intensities for each beneficiary undertaking.
3. Aid may be awarded concurrently under several aid schemes or cumulated with ad hoc aid, provided that the total amount of state aid for an activity or project does not exceed the aid ceilings laid down in this framework. Where Union funding (see 1.) is combined with state aid, the total amount of public funding awarded in relation to the same eligible costs must however not exceed the most favourable funding rate laid down in the applicable rules of Union law.

Table 4 provides the associated maximum aid intensities for LSIs. When different sources are combined (e.g. national with regional funding, see Box 9), their overall financing should not exceed the suggested intensities. This also holds for indirect funding via RTOs or Universities. Funding from framework programmes is exempt from the State Aid rules.

	Small Enterprise	Medium sized Enterprise	Large Enterprise
Aid for R&D projects			
Industrial research	70%	60%	50%
• subject to collaboration between undertakings (for large undertakings cross-border or with at least one SME) or between an undertaking with a research organization; or • subject to wide dissemination of results	80%	75%	65%
Experimental development	45 %	35 %	25 %
• subject to collaboration between undertakings (for large undertakings cross-border or with at least one SME) or between an undertaking with a research organization; or • subject to wide dissemination of results	60 %	50 %	40 %

Table 4: Aid intensities associated to different forms of R&D&I.

Based on the table with the maximum aid intensities for LSIs, it should be concluded that under certain conditions, aid intensities of over 50% are allowed. The implicit policy objective generally adopted by many national and regional governments however is to limit public funding to 50%. This objective seems prompted by uncertainties about how to interpret the State Aid rules, and the subsequent assessment of aid for LSIs by the EC / DG Competition.

Recommendation 3

A clear and ambiguous set of rules should be formulated, dedicated specifically to LSIs (or similar types of PPPs with infrastructure addressing pilot production and demonstration), concerning the allowed aid intensities for such entities and their activities.

Recommendation 4

More specifically, it should be analysed how Member States could support the set-up and continuation of LSIs within the framework of the Important Projects of common European Interest (EPCI) initiatives, with corresponding criteria for public support.[37]

Box 10: Characteristics of eligible LSI related costs under the State Aid rules

The State Aid rules define PPPs such as LSIs and their corresponding activities as a form of industrial research or experimental development. These forms of research are defined as follows:

- Industrial research means the planned research or critical investigation aimed at the acquisition of new knowledge and skills for developing new products, processes or services or for bringing about a significant improvement in existing products, processes or services. It comprises the creation of components parts of complex systems, and may include the construction of prototypes in a laboratory environment or in an environment with simulated interfaces to existing systems as well as of pilot lines, when necessary for the industrial research and notably for generic technology validation.
- Experimental development means acquiring, combining, shaping and using existing scientific, technological, business and other relevant knowledge and skills with the aim of developing new or improved products, processes or services. This may also include, for example, activities aiming at the conceptual definition, planning and documentation of new products, processes or services. Experimental development may comprise prototyping, demonstrating, piloting, testing and validation of new or improved products, processes or services in environments representative of real life operating conditions where the primary objective is to make further technical improvements on products, processes or services that are not substantially set. This may include the development of a commercially usable prototype or pilot which is necessarily the final commercial product and which is too expensive to produce for it to be used only for demonstration and validation purposes. Experimental development does not include routine or periodic changes made to existing products, production lines, manufacturing processes, services and other operations in progress, even if those changes may represent improvements.

Eligible costs for industrial research and experimental development include:

- Personnel costs: researchers, technicians and other supporting staff to the extent employed on the project.
- Costs of instruments and equipment to the extent and for the period used for the project. If such instruments and equipment are not used for their full life for the project, only the depreciation costs corresponding to the life of the project, as calculated on the basis of good accounting practice, are considered as eligible.
- Costs of buildings and land, to the extent and for the period used for the project. With regard to buildings, only the depreciation costs corresponding to the life of the project, as calculated on the basis of good accounting practice are considered as eligible. For land, costs of commercial transfer or actually incurred capital costs are eligible.
- Cost of contractual research, knowledge and patents bought or licensed from outside sources at arm's length conditions, as well as costs of consultancy and equivalent services used exclusively for the project.
- Additional overheads incurred directly as a result of the project.
- Other operating expenses, including costs of materials, supplies and similar products incurred directly as a result of the project.

Key bottlenecks in public funding for LSIs

Analysis within the framework of EU-GREAT! indicates that within the EU, many public funding instruments exist that address the financing of LSIs. For a (non-comprehensive) overview of funding mechanisms and their pros and cons in Member States, see Deliverable 5.2 of the EU-GREAT!

[37] See http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52014XC0620(01).

The divergence in instruments and their in modality is illustrated well by the availability of Structural Funds (SF) for R&D&I in the different Member States. For some countries (e.g. Spain), SF and regional co-funding are the main source of public support for R&D&I, and thereby for LSIs and their projects. For other countries (e.g. the Netherlands), SF represent for example just a fraction of the total budget for tax measures addressing R&D&I projects.

The economic crisis that started in 2008 has resulted in retrenchments in public funding for R&D&I in many EU countries. This is problematic especially for LSIs that are in the start-up phase, that need considerable public support for example for the purchase of infrastructure and the build-up of research capacity. Established LSIs that are in the process of raising public support for their continuation seem better able to handle these budget cuts, as they already gained a certain reputation, and secured contacts with funding agencies. This seems to give them an advantage in comparison to others when competing for public support. It is also argued that the continuation of an LSI requires less public support in comparison to the start-up of such an initiative.

Recommendation 5

Given the role and contribution of LSIs in the European innovation system, and the lack of overall public funding available for these entities, additional budget should be allocated to public instruments (EU, national as well as regional) addressing large-scale research, development, and innovation initiatives.

Our analysis within the framework of EU-GREAT! confirms LSIs are required to look for and combine different instruments. This issue has become more prominent with retrenchments in total budget of instruments resulting from the 2008 economic crisis. LSIs subsequently are not able to cover their need for public funding by a single instrument (or a combination of a limited number of them). This combining of different instruments has several implications that hinder the set-up or continuation of an LSI:

- Actors involved in finding public support for an LSIs are often not familiar with the wide variety of funding instruments on regional, national and European level. Hence, they find it challenging to make optimal use of the available instruments.
- Instruments on national, regional and EU-level are not aligned; they have different (and sometimes diverging) objectives, thematic priorities and modalities, and cover different parts of the innovation chain. Combining them subsequently becomes very complex (notably for cross-sectoral initiatives).
- The use of multiple instruments implies additional and extensive acquisition and reporting costs. To create and maintain a coherent and stable research programme over some years, based on a variety of funding sources, extensive ‘financial engineering’ is necessary for LSIs. Extra capacity, for example is in the area of accounting or writing proposals, is often needed. The subsequent costs for acquisition and reporting makes up a significant share of the LSIs’ budgets.
- In many Member States there is furthermore no central entity that coordinates the further combination (integration) of delivery of EU, national, and regional instruments. This complicates the search for public funding by LSIs, and requires additional internal coordination of applications for support.

- Using multiple funding sources also bears the risk of undermining continuity (caused for example by alterations in policy orientation with parliamentary changes). If a LSI relies on several sources, fluctuation in funding is likely, as it cannot be predicted how much funding will be awarded over time. This makes the planning of projects less predictable and can refrain private parties from investing.
- The funding of long term research programmes requires as explained the use of several public funding instruments (national as well as regional and from the EU). It is common to agree on fixed project steps and deliverables, which are monitored throughout the programme and its corresponding projects. In case a new opportunity arises, for example due to a new technical innovation, LSIs sometimes find it difficult to work on this opportunity within existing programmes with corresponding projects as they are obliged to deliver the promised outputs, and deviations are not foreseen.

Recommendation 6

Funding of complex entities like LSIs requires a simple and straightforward system of policy delivery (acquisition as well reporting). Immediate steps are required to align the different (modalities of) instruments, from different sources (national, regional as well as EU).

Objective should be to set-up a one stop shop for LSIs, that should address project funding as well as the immediate and structural financing gap. Flexibility in the mix of instruments and their corresponding objectives and delivery is thereby essential, as to address the specific and varying characteristics of LSIs.

Recommendation 7

An important additional recommendation for further research would be to analyse if a dedicated public instrument for PPPs such as LSIs is required, or if ad-hoc support would be more effective. The latter would require additional analysis concerning potential infringements of the State Aid rules.

Recommendation 8

Especially within the framework of long-term research programmes, flexibility in the implementation of projects should be allowed in order to ensure a valuable contribution to the stakeholders involved in the LSI.

Potential role of debt financing for the set-up or continuation of LSIs

Debt financing is often mentioned as a promising instruments for financing LSIs by policy makers. Our previous analysis suggests that its role seems limited to addressing the immediate financing gap. Several interviews conducted within the framework of EU-GREAT however suggests that debt funding in general is not considered as an effective solution by the vast majority of actors involved in LSIs. Many LSIs have a non-commercial (i.e. not for profit) character, and the income it generates, especially at the beginning, is far from ensured. This limits their willingness to commit to the requirements of a loan. Note that this poses questions concerning the effectiveness of public support for a LSI with a revolving element.

Recommendation 9

It should be analysed how EIB financing measures could be deployed successfully for the support of LSIs, as their current use seems limited.

Our analysis furthermore indicates that commercial banks adopt specific and dedicated models to assess a request by a loan for either an entity like a LSI, or a project running on it.[38] The models are currently subject to changes in the regulations that govern granting of credits, initiated by the ECB. The outcome of the new regulations are currently subject to negotiation.[39] Further analysis is needed

Providing debt financing for a PPP like a LSI (i.e. for the financing of the entity itself) is subsequently considered by a commercial bank, because of its specific characteristics, as providing a loan for real estate. Complicating factor in the case of the financing of such a PPP is that the assets (i.e. equipment) are unique, and specific in use. In case of insolvency of an entity like a LSI, the execution value of the assets is subsequently rather limited. Basis for the evaluation of a request for the provision of a loan is therefore primarily the assessment of the cash-flow generated by the PPP (i.e. profit and its uncertainty).

Because of the above, commercial banks seem not able to finance an LSI. It is explicitly mentioned however that a guarantee for a loan (by *any* of the partners in the PPP) would (of course) alter their decision concerning investing in an entity such as a LSI. An important question for further research would be who could (and would be willing to) provide a guarantee such that debt financing could be an effective toll in order to address the immediate financing gap.

The use of not-institutionalized ad-hoc government support as a form of basic funding (i.e. not part of a long-run programme) for a PPP to balance the budget (i.e. to address the structural financing gap) seems for most commercial banks an indication of high risk with respect to the long-run continuation of the entity. The willingness to provide debt-financing is subsequently limited.

Commercial banks would be interesting in financing projects that would be conducted within the framework of an entity such as a LSI. But for banks it is difficult to assess the potential failure rate and impact of R&D&I (because of information asymmetries). Also, because of banking regulations, their perception of the subsequent risks is also not favourable for projects with high uncertainty concerning failure and impact. Commercial banks are therefore willing / able to get involved only in the very late stages of the innovation process.

Recommendation 10

Additional research is required addressing the potential limitations of banking regulations with respect to the financing of LSIs.

The above implies however that requests for debt financing of projects are assessed in a different way than requests for the financing of a LSI. Commercial banks describe that as a bottom up approach where also non-tangible assets are assessed (i.e. project characteristics, participants (based on reputation), corresponding business plan, etc.).

[38] See www.eu-great.com.

[39] It should be noted however that a loan based on (future) IP seems no longer possible due to changes in (internal) banking regulations.

Commercial banks would be interested in linking to an entity like a LSI, because it would provide them with access to partners that have the potential to grow to large actors that could require banking services with high(er) yields.

Recommendation 11

Combined financing of public funding and private debt financing (as well as equity financing) however could result in the situation that part of the public support is used for the financing of debt (and equity). A question for debate is whether this is possible / advisable under the current regulations.

It is the perception of some commercial banks that when a Venture Capitalist is involved in what they define as a prospect, that the VC excludes additional debt financing by means of traditional commercial banks. The rationale for the behaviour of the VC is that it wants complete control over all financial aspects of the company.

Recommendation 12

An issue for further research is whether other forms of debt financing, such as a subordinated debt, could be an effective means for addressing the immediate financing gap of LSIs.

Potential role of equity financing for the set-up or continuation of LSIs

Several interviews conducted within the framework of EU-GREAT indicate that private equity firms usually only invest in what they define as a "prospect" (i.e. a company with a corresponding product - and rarely a service - the VC considers investing in) only if it has the potential to grow rapidly (i.e. a convex growth curve). An important aspect in the assessment of the possibilities for growth is the potential scaling-up of the underlying concept from a single (geographical) market to multiple markets.[40]

An important condition for involvement of venture capital is the possibility of an exit strategy to capitalize the increase in value of the company. An exit strategy is a way to transition the ownership of a company to another company (e.g. through a merger or acquisition) or to investors (e.g. through an Initial public offering). Other types of exit strategy include management buyouts or employee buyouts (common in the manufacturing industry).

Box 11: Venture capital and the structural financing gap

In theory, venture capitalists might be willing to invest in a company PPSs, thereby closing the structural financing gap, as they perceive that they have a positive impact on the success of innovations (see Hellman, T., & Puri, M. (2000), *The interaction between product market and financing strategy: The role of venture capital, Review of Financial studies*, 13(4), 959-984.; Kortum, S., & Lerner, J. (2000), *Assessing the contribution of venture capital to innovation*, RAND journal of Economics, 674-692). In practice however, venture capitalists require an clear exit strategy (see Tirole, J. (2006), *The Theory of Corporate Finance, Princeton University Press*), making PPSs in many cases an uninteresting investment prospect.

Our analysis within the framework of the EU-Great project therefore seems to suggest that a PPP such as a LSI is not an interesting prospect, as the underlying concept is not scalable (i.e. it is duplicable), and it (subsequently) does not seem to have rapid growth potential. An exit strategy seems furthermore very complicated.

[40] An example in this perspective is the taxi App Uber from Uber Technologies Inc.; a successful concept that has been implemented 66 countries and 507 cities worldwide.

Our analysis furthermore seems to suggests that VCs are not very interested in getting involved in projects conducted within the framework of a LSI. A Venture Capitalist invests in IP (and not in tangible assets, as in general the company that represents the prospect does not own these yet). IP resulting from activities conducted within the framework of an LSI is often shared (especially in the case of co-funded collaborative research)over different partners. This complicates the exit strategy of a VC.

Recommendation 13

Additional analysis is required to analyse the potential involvement of other actors involved in equity financing in the financing of LSIs, that adopt a different strategy concerning the weighted risks in their portfolio of participations, such as those involved in private equity and real estate. Condition for their participation would be a certain level of assets and return on investment (with low risk).