

Evidence Review 9

**Innovation:**  
grants, loans and  
subsidies

October 2015



what works centre for  
local economic growth



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# Preface

This report presents findings from a systematic review of evaluations of programmes that aim to support innovation – the development and diffusion of new products and processes – by providing grants, loans and subsidies for research and development activity (R&D). It is meant to sit alongside our similar review of tax credits for R&D activity.

Together these reports comprise the ninth review produced by the [What Works Centre for Local Economic Growth](#). The What Works Centre is a collaboration between the [London School of Economics and Political Science](#), [Centre for Cities](#) and [Arup](#) and is funded by the [Economic & Social Research Council](#), [The Department for Communities and Local Government](#) and [The Department for Business Innovation & Skills](#).

These reviews consider a specific type of evidence – **impact evaluation** – that seeks to understand the causal effect of policy interventions and to establish their cost-effectiveness. To put it another way they ask ‘did the policy work’ and ‘did it represent good value for money’? By looking at the details of the policies evaluated we can also assess what the evidence tells us about delivery issues – for example, is there any evidence that schemes with a particular sectoral focus do better than other schemes?

Evidence on impact and effectiveness is a crucial input to good policy making. Process evaluation – looking in detail at how programmes operate – provides a valuable complement to impact evaluation, but we do not focus on this. We recognise that may sometimes cause frustration for practitioners who are responsible for delivery.

However, we see these impact-focused reviews as an essential part of more effective policy making. We often simply do not know the answers to many of the questions that might reasonably be asked when implementing a new policy – not least, does it work? Figuring out what we do know allows us to better design policies and undertake further evaluations to start filling the gaps in our knowledge. This also helps us to have more informed discussions about process and delivery issues and to improve policymaking.

These reviews therefore represent a first step in improving our understanding of what works for local economic growth. In the months ahead, we will be working with local decision makers and practitioners, using these findings to help them generate better policy.

Henry Overman

Director, What Works Centre for Local Economic Growth



# Executive Summary

This report presents findings from a systematic review of evaluations of programmes that aim to support innovation by providing grants, loans and subsidies for research and development activity (R&D). A companion report looks at R&D tax credits. Other measures to support innovation will be considered in further work. This review is the ninth produced by the What Works Centre for Local Economic Growth.

The review considered around **1,700** studies from the UK and other OECD countries (covering all aspects of support for innovation). This review considers the **42** impact evaluations that covered programmes offering R&D grants, loans and subsidies and that met the Centre's minimum standards.

This is a smaller evidence base than for our first review (on employment training) although roughly comparable to our second and third reviews (on business advice and the impact of cultural and sports projects, respectively), and larger than our reviews of business access to finance, estate renewal programmes and transport investment. This may still be larger than the evidence base for many other local economic growth policies. However, it is a small base relative to that available for some other policy areas (e.g. medicine, aspects of international development, education and social policy).

**The 42 evaluations reviewed looked at one or more of three broad outcomes of interest: R&D expenditure, innovation and economic outcomes. For any one of these broad outcomes, around half of the evaluations that looked at that outcome found positive effects. More specifically, eight of 18 find positive programme impacts on R&D expenditure; 10 out of 16 find positive effects on innovation (patents or self-reported process or product innovation) and eight out of 17 find positive effects on economic outcomes (productivity, employment of firm performance – profits, sales or turnover).**

## Approach

The Centre seeks to establish causal impact – an estimate of the difference that can be expected between the outcome for firms in the programme and the average outcome they would have experienced without the programme (see Figure 1). Our methodology for producing our reviews is outlined in Figure 2.

Figure 1: Evaluating impact

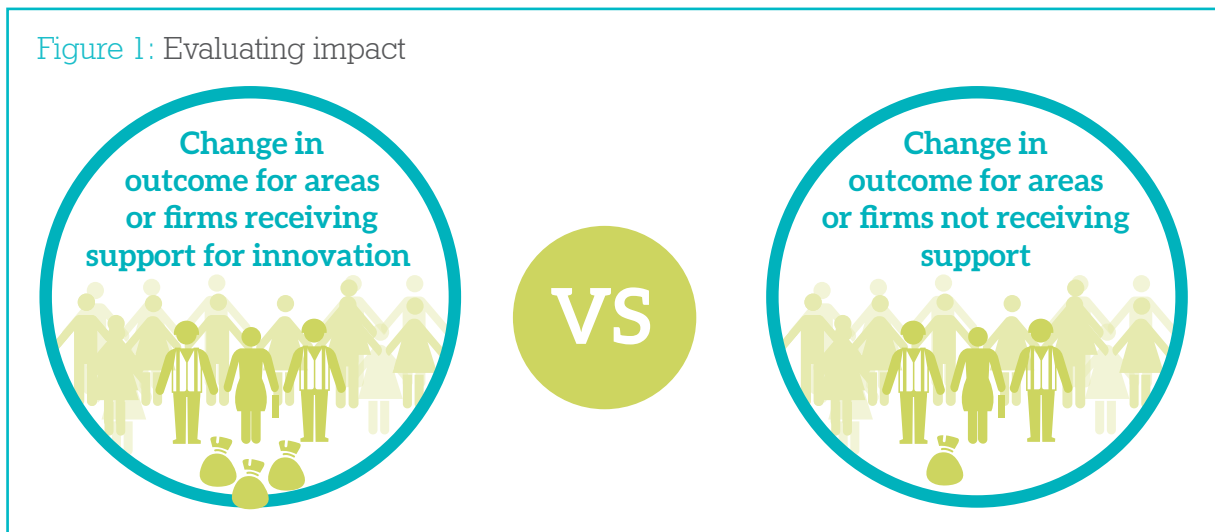
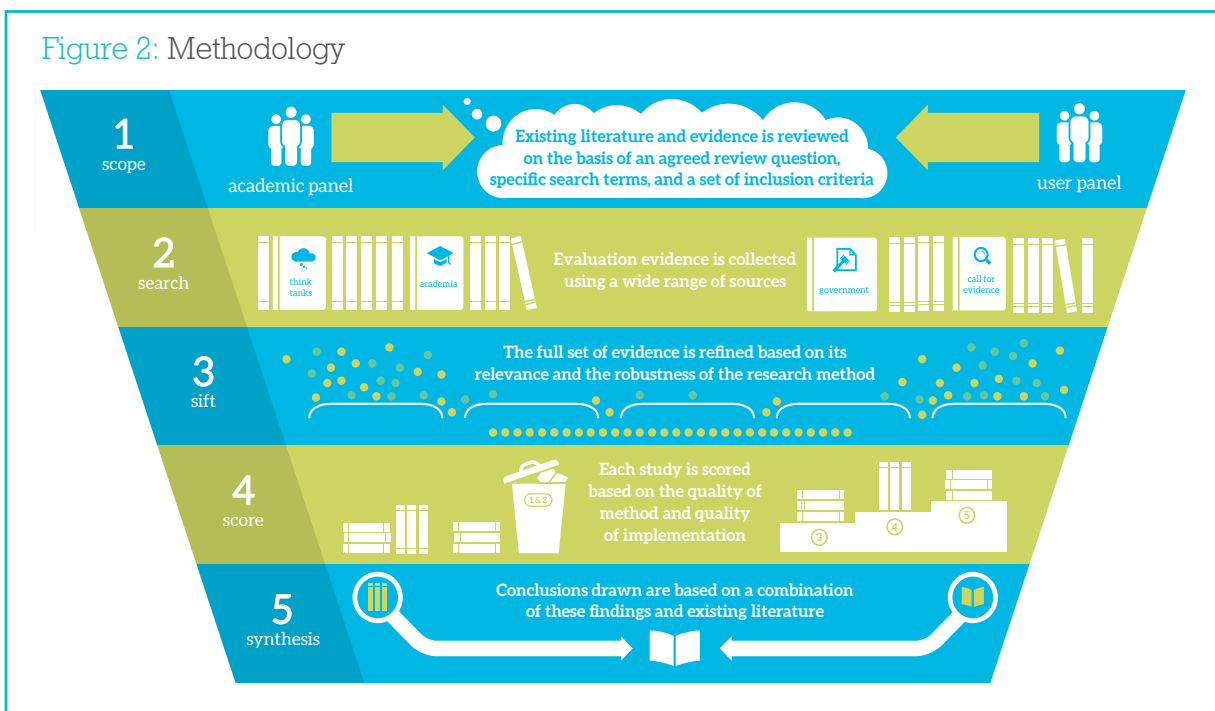


Figure 2: Methodology



## Findings

### What the evidence shows

- R&D grants, loans and subsidies can positively impact R&D expenditure, although effects are not always positive.
- R&D grants, loans and subsidies can raise innovative activity in recipients, although again effects are not always positive. The effects differ across types of innovation, and are weaker

for patents than for (self-reported) measures of process or product innovation.

- R&D grants, loans and subsidies can positively impact productivity, employment or firm performance (profit, sales or turnover). There is some evidence that support is more likely to increase employment than productivity.
- R&D grants, loans and subsidies are more likely to improve outcomes for small to medium-size companies than for larger ones. In part this may be because for larger firms, public support makes up a relatively small amount of overall R&D spend, so positive effects are harder to detect. Smaller firms may also be more likely to formalise processes in anticipation of, or response to, a grant, so that some innovation-related spend is reclassified as R&D.
- Programmes that emphasise collaboration perform better than those that just support private firms (as well as those where the programme focus is unclear). Encouraging collaboration might have an additional positive effect on the likelihood that an R&D support programme generates positive effects on outcomes of interest.
- Programmes that target particular production sectors appear to do slightly worse in terms of increasing R&D expenditure and innovation, compared to those that are 'sector neutral'.

### Where the evidence is inconclusive

- Evidence on the extent to which public support crowds out private investment is mixed.

### Where there is a lack of evidence

- There is little impact evaluation evidence on key aspects of programme design, such as eligibility criteria and targeting programmes by firm size.
- Relatively few evaluations consider the timing of effects. In particular, there is a lack of studies considering long-term impacts of interventions (ten years plus). However, the small number of studies that are able to consider the time profile of effects, do not suggest that programme effects get stronger over time.
- Relatively few evaluations consider more than one element of the 'chain' from increased R&D spend, through innovation, to improved firm performance. Results from these studies are mixed.
- Programme spend and operational cost data is rarely available to evaluators. This makes it very hard to assess the cost-effectiveness of public R&D grants and subsidy interventions.

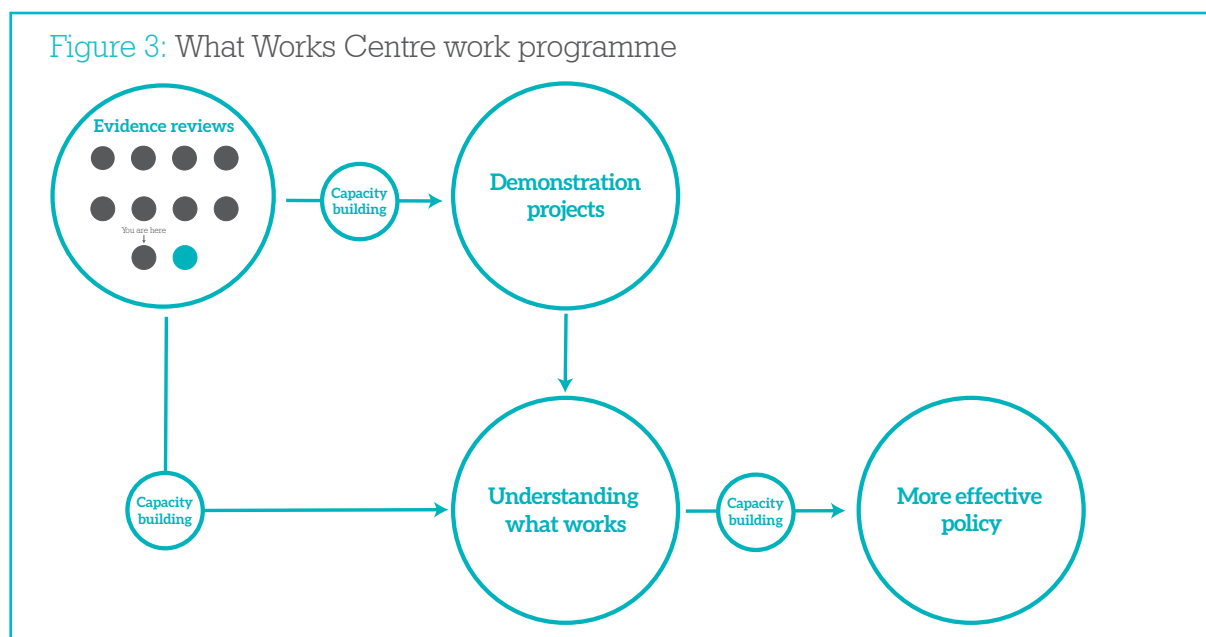
### How to use these reviews

The Centre's reviews consider a specific type of evidence – impact evaluation – that seeks to understand the causal effect of policy interventions and to establish their cost-effectiveness. The Centre has now produced a range of evidence reviews that can help local decision makers decide the broad policy areas on which to spend limited resources. Figure 3 illustrates how the reviews relate to the other work streams of the Centre.

### Supporting and complementing local knowledge

This evidence review does not address the specifics of 'what works where' or 'what will work for a particular locality'. An accurate diagnosis of the specific local challenges policy seeks to address needs to be the first step in understanding how the overall evidence applies in any given situation.

However, while detailed local knowledge and context will be important in undertaking that analysis,



as in most policy areas we have considered, the evidence presented here doesn't make the case for local over national delivery (or vice-versa).

The evidence does urge caution on the role that more localised innovation policy could play in driving local economic growth. Local decision makers need to think carefully about their desired objectives. For example, our companion review on tax credits shows that they have a pretty good success rate in raising R&D spending (particularly for smaller / younger firms). Equally, R&D grants programmes which include a collaboration element seem effective at raising R&D activity. But in both cases we know much less about whether or how this increased R&D activity feeds through to greater innovation, better firm performance or longer term economic growth, particularly at the local level. These broader outcomes are the things most local economic decision makers ultimately care about.

There are also good reasons to think that many of these broader economic benefits are likely to 'spill over' beyond the immediate area in which the policy is implemented. This might still result in a net benefit for the place implementing the policy, but such spillovers reduce the economic benefits to individual areas and strengthen the case for national policy.

Local R&D support programmes could also result in inefficiently high levels of support if footloose firms are able to extract more generous support from competing local areas regardless of any net beneficial impact. Any moves to devolve policy in the UK would need to test for these issues.

Overall, then, it is important to remember that evaluation of the impact of innovation policy is still limited and this review raises as many questions as answers. The limited evidence base, particularly in terms of the impact on local economic outcomes, highlights the need for realism about the capacity and evidence challenges of delivering innovation policy at a more local level.

## Helping to fill the evidence gaps

Given the importance of R&D support programmes in the innovation policy mix – and in wider policy agendas such as industrial strategy – it is important to think how we might generate further high quality impact evaluation evidence. Study 1208, which evaluates the UK R&D tax credit, is one

example of best practice, which combines detailed administrative data (from HMRC) with scheme performance data, and exploits a change in scheme design to evaluate impact.

Government could help evaluate other policies by releasing similar datasets, including cost data, to researchers (to allow construction of treatment and control groups and calculations of cost-effectiveness). Policymakers should also think about how to implement policies in ways that facilitate evaluation – for example, through competitive application processes, or by staggering programme rollout across locations and/or time.

Very few studies look at economic effects of R&D support beyond immediate impacts on R&D spend, to consider patents or reported innovation, or wider firm or area-level outcomes, such as productivity or concentrations of star scientists. If the ultimate aim of R&D support policies (especially at the local level) is to influence innovation and growth, it is crucial that we evaluate future policies against these wider objectives. To do this, policymakers have to ensure that researchers can link firm-level data on tax, financial assets, productivity, jobs and innovative activities.

We need a much better sense of how different forms of R&D support perform against each other (grants / subsidies / loans vs tax credits), and against other aspects of innovation policy (such as those covered in NESTA's Compendium of Evidence on Innovation Policy). Better data on scheme reach and participants will help researchers to do this.

Similarly, we need more evidence on the appropriate policy mix, including whether regional or urban-level policy is appropriate. Innovative activity tends to cluster, and local 'ecosystems' often have unique characteristics. This implies that local policy could have a role to play. But as we discussed above, the benefits of innovation is not always spatially bounded, and traditional local cluster programmes have a very poor success rate.

The Centre's longer term objectives are to ensure that robust evidence is embedded in the development of policy, that these policies are effectively evaluated and that feedback is used to improve them. To achieve these objectives we want to:

- work with local decision makers to improve evaluation standards so that we can learn more about what policies work, where.
- set up a series of 'demonstration projects' to show how effective evaluation can work in practice.

Interested policymakers please get in touch.





# Introduction

This review looks at the effectiveness of public grants, loans and subsidies for research and development activity (R&D). It is a part of a wider set of reviews summarising findings from evaluations of innovation policy.

Innovation is usually defined as the ‘invention, diffusion and exploitation of new ideas’.<sup>1</sup> Innovation is an important influence on long term economic development, and investment in R&D is central to this. Economists identify two key linkages from R&D to wider growth.<sup>2</sup>

- First, firms conduct R&D to find ways to cut costs; to develop smarter ways of working; and to develop new goods and services.<sup>3</sup> Those product and process innovations may, in turn, feed through to higher productivity, higher sales and profits for the firm. In turn, this helps recoup at least some of the cost of the original investment.
- Second, R&D by one firm may also spillover and benefit other individuals, firms or organisations. This means that the wider gains from R&D to society, which economists refer to as the ‘social returns’, may be greater than firms’ private returns.<sup>4</sup>

These knowledge spillovers occur because new ideas permeate outside the firm: as key staff take new jobs, or set up new companies; through imitation and reverse engineering by competitors; and because forms of intellectual property protection, like patents and trademarks, don’t offer complete and permanent coverage. This wider diffusion process is often disruptive, as in Schumpeter’s notion of ‘creative destruction’.<sup>5</sup>

The available evidence suggests that returns to private R&D are positive in most countries, and typically higher than regular capital investment. A 2010 survey by Hall et al suggests returns to R&D of 20-30% in more developed countries during the second half of the last century. Social returns are harder to estimate, but may be higher still: typically over 30% and in some cases even over 100% for studies over the same time period.<sup>6</sup>

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1 Fagerberg (2005).

2 Two seminal endogenous growth contributions are Lucas (1988) and Romer (1990).

3 Hall et al (2010).

4 Griliches (1992), Jaffe (1996), Hausmann et al (2003), Rodrik (2004).

5 Schumpeter (1962).

6 Hall et al (2010).

These spillovers help explain why most governments directly and indirectly support R&D, as part of a broader portfolio of innovation policies. If the firm that makes the R&D investment bears the cost, but others across the economy benefit from the new knowledge, then society would invest far too little in new knowledge if R&D activity was left only to the market. What is more, research at the knowledge frontier has highly uncertain payoffs and often requires expensive investment by firms, for example in specialist staff and equipment: these factors may also lead to sub-optimal levels of R&D. Some R&D activities may also exhibit ‘network spillovers’ due to their cost and complexity, which create further disincentives for firms.

In practice, governments seek to generate both public R&D (through direct grants to universities and government labs) and private R&D (through grants, loans and subsidies to businesses, and through tax policy). We explore R&D tax credits in a companion review.

The spillover argument implies that governments should support investment in R&D – for example by funding R&D directly or by *complementing* private sector activities through subsidies or making parallel public investments.<sup>7</sup> For example, government can influence R&D activity by doing its own research; by funding universities and public research labs; or by funding private sector research through grants, loans and contracts. Government may also support R&D indirectly through tax credits or other incentives.<sup>8</sup>

R&D focused programmes should be seen as part of the wider innovation policy mix. A number of schemes reviewed in this report combine subsidy with networking and collaboration activity, for example: EU grants typically require a partnership that spans two or more member states. There are also overlaps with other policy agendas, notably business support, access to finance and industrial policy. For instance, in practice, public or co-funded venture capital activity will also influence firms’ R&D, since firms targeted by VC investors are often in knowledge-intensive sectors.

As this short introduction makes clear, innovation policy can involve a wide range of very different interventions. As we discuss below, it is also an area in which comprehensive evaluation is challenging.<sup>9</sup>

At the most basic level, innovation is not a linear process. Pathways from R&D funding to innovation can be iterative and unpredictable. More broadly, firms’ and public sector opportunities may be shaped by previous decisions and trends (processes known as ‘path-dependence’).<sup>10</sup> This can make identifying causal effects of interventions extremely difficult.

This has important implications for our evidence reviews, given their focus on impact evaluation. Preliminary sifts of the literature identified two areas for which there existed a sufficient number of impact evaluations to undertake a systematic review: R&D grants, subsidies and loans, including collaboration/networking interventions associated with these policies and tax credits and other fiscal incentives. This review considers the first of these assessing the impact of R&D grants, subsidies and loans.

What can we expect these programmes to achieve? As set out above, there are multiple potential impact channels which may interact with and feedback on each other. R&D support to firms should translate into ‘innovation outcomes’ like patenting, trademarks and new products/processes. In turn, that may feed through to higher productivity, higher sales/profits and increased employment in the investing firms – assuming they are able to effectively commercialise the knowledge. Knowledge spillovers should diffuse these benefits more broadly across the economy in a range of ways. These spillovers may, however, reduce the ability of individual firms to benefit from new R&D in terms of higher sales and profits (and related employment growth).

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7 Rodrik (2004) and Harrison et al (2009).

8 Martin and Hughes (2012).

9 For one recent attempt see NESTA’s Compendium of Innovation Evidence, which comprises 19 evaluations, plus a synthesis report, combining case study, process and impact evaluation material.

10 David (1985) is the classic article. For a more recent review of the concept, see David (2007): <http://www-siepr.stanford.edu/workp/swp06005.pdf>

R&D spending in universities or public research labs can also have impact through multiple pathways: new knowledge and its applications; training and upskilling researchers; networks between researchers and firms; contract research and the generation of new spinout and startup firms.<sup>11</sup> These wider economic outcomes are clearly harder to attribute to the original policy, making it easier (although not easy) to track effects for programmes that fund private firms/partnerships directly, compared with programmes that fund public science.<sup>12</sup>

There are also crucial aspects of these interventions which further complicate evaluation. In particular, identifying the additional effect of programmes is challenging. For example, public R&D spending might crowd out investments that private firms would have made anyway. This is a big issue in areas like venture capital, where a market typically exists but government may wish to grow it further.

In addition, because R&D grants programmes for firms are often open to all, we might worry that the best (or worst) performing businesses might ‘select into’ the programme, so that participants are not representative of target businesses as a whole. This can lead evaluations to over (or under) estimates of the true effect of the intervention. The impact of grants and subsidies is also conditional on firms’ ‘absorptive capacity’ – for instance, the presence of qualified staff, suitable equipment, connections to experts or previous organisational experience. A recent review suggests that direct R&D support may have more impact when delivered in tandem with business advice or other support.<sup>13</sup> This means that the impact of support may be quite heterogeneous across different types of firms. We will discuss these issues further, below.

More broadly, neither the private sector nor policymakers can predict exactly which experiments and new ideas will succeed; so public policies need to be able to identify promising areas of support without the ability to pick individual winners. At the same time, policies have to engage with industry – to ensure the programme reaches those who need it most – without being captured by vested interests. This means that governance, rules and processes may be just as important as policy content.<sup>14</sup> As a result, policies that look similar (i.e. ‘give out grants’) may differ substantially in their design in ways that matter for impacts. Unfortunately, our ability to say much about these design elements is limited by the evidence available.

A final issue is the *scale* of policy effects. Knowledge can easily spill over local boundaries, benefiting firms across the economy.<sup>15</sup> This may be good for national welfare, but will lessen the direct impact on local economic growth. This might still result in a net benefit for places implementing the policy, but spillovers would need to be taken into account in evaluating impacts. Such spillovers are one important reason why R&D grants and subsidies are often devised by national government; even if some aspects of delivery take place locally.

In short, evaluating the impacts of R&D grants, subsidies and loans is extremely complex, even if the policy itself may seem relatively simple. The likely economic outcomes are hard to predict, hard to measure and evaluate, and may differ substantially at local and national level. This is reflected in our review: we find a number of impact evaluations that meet our minimum quality thresholds, but very few that can precisely identify the full range of policy effects (and none that can attribute this to specific aspects of programme design).

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11 Martin and Hughes (2012).

12 Cunningham et al (2013).

13 Cohen and Levithal (1990) provide the classic analysis. Cunningham et al (2013) survey recent evidence.

14 For an economics take on these issues see Jaffe (1996) or Rodrik (2004). Other useful insights come from Lerner (2009), Foray et al (2012) and Cunningham et al (2013).

15 Jaffe (1996) and Rodrik (2004).

# 04

## Impact evaluation

Governments around the world increasingly have strong systems to monitor policy inputs (such as spending on R&D grants) and outputs (such as the number of firms and researchers receiving grants). However, they are less good at identifying policy *outcomes* (such as the effect of R&D grants on firm patenting or employment). In particular, many government-sponsored evaluations that look at outcomes do not use credible strategies to assess the **causal impact** of policy interventions.

By causal impact, the evaluation literature means an estimate of the difference that can be expected between the outcome for groups ‘treated’ in a programme, and the average outcome they would have experienced without it. Pinning down causality is a crucially important part of impact evaluation.

**Estimates of the benefits of a programme are of limited use to policy makers unless those benefits can be attributed, with a reasonable degree of certainty, to that programme.**

The credibility with which evaluations establish causality is the criterion on which this review assesses the literature.

### Using counterfactuals

**Establishing causality requires the construction of a valid counterfactual** – i.e. what would have happened to programme participants had they not been treated under the programme. That outcome is fundamentally unobservable, so researchers spend a great deal of time trying to rebuild it. The way in which this counterfactual is (re)constructed is the key element of impact evaluation design.

**A standard approach is to create a counterfactual group of similar individuals not participating in the programme being evaluated.** Changes in outcomes can then be compared between the ‘treatment group’ (those affected by the policy) and the ‘control group’ (similar individuals not exposed to the policy).

**A key issue in creating the counterfactual group is dealing with the ‘selection into treatment’ problem.** Selection into treatment occurs when participants in the programme differ from those who do not participate in the programme.

Examples of this problem in R&D programmes would be when only more ambitious firms apply for an ‘open to all’ programme of grants or subsidies, or when a commission of experts scores proposals

to decide funding. If this happens, estimates of policy impact may be biased upwards. In the case of the open to all programme, we incorrectly attribute better firm outcomes (say, patenting) to the policy, rather than to the fact that the participants would have filed a lot of patents even without the programme. In the case of the expert commission, even though the programme is *designed* to select the ‘best’ participants, we should still worry that the *additional* effect of the programme may be small, or even zero.

Selection problems may also lead to downward bias. For example, firms may use support to fund marginal projects, or firms that apply for R&D programmes might be experiencing problems in coming up with innovative ideas: such firms may be less likely to grow or succeed independent of any support they receive from collaborating.

These factors are often unobservable to researchers. **So the challenge for good programme evaluation is to deal with these issues, and to demonstrate that the control group is plausible.** If the construction of plausible counterfactuals is central to good policy evaluation, then the crucial question becomes: **how do we design counterfactuals?** Box 1 provides some examples.

#### Box 1: Impact evaluation techniques

One way to identify causal impacts of a programme is to randomly assign participants to treatment and control groups. For researchers, such **Randomised Control Trials** (RCTs) are often considered the ‘gold standard’ of evaluation. Properly implemented, randomisation ensures that treatment and control groups are comparable both in terms of observed and unobserved attributes, thus identifying the causal impact of policy. However, **implementation of these ‘real world’ experiments is challenging and can be problematic.** RCTs may not always be feasible for local economic growth policies – for example, policy makers may be unwilling to randomise.<sup>16</sup> And small-scale trials may have limited wider applicability.

Where randomised control trials are not an option, **‘quasi-experimental’** approaches of randomisation can help. These strategies can deal with selection on unobservables, by (say) exploiting institutional rules and processes that result in some firms quasi-randomly receiving treatment.

Even using these strategies, though, the treatment and control groups may not be fully comparable in terms of observables. Statistical techniques such as **Ordinary Least Squares** (OLS) and **matching** can be used to address this problem.

Note that higher quality impact evaluation first uses identification strategies to construct a control group and deal with selection on unobservables. Then it tries to control for remaining differences in observable characteristics. It is the combination that is particularly powerful: OLS or matching alone raise concerns about the extent to which unobservable characteristics determine both treatment and outcomes and thus bias the evaluation.

## Evidence included in the review

**We include any evaluation that compares outcomes for firms receiving treatment (the treated group) after an intervention with outcomes in the treated group before the intervention, relative to a comparison group used to provide a counterfactual of what would have happened to these outcomes in the absence of treatment.**

<sup>16</sup> Gibbons, Nathan and Overman (2014).

This means we look at evaluations that do a reasonable job of estimating the impact of treatment using either randomised control trials, quasi-random variation or statistical techniques (such as OLS and matching) that help make treatment and control groups comparable. We view these evaluations as providing credible impact evaluation in the sense that they identify effects which can be attributed, with a reasonable degree of certainty, to the implementation of the programme in question. A full list of shortlisted studies is given in Appendix A.

## Evidence excluded from the review

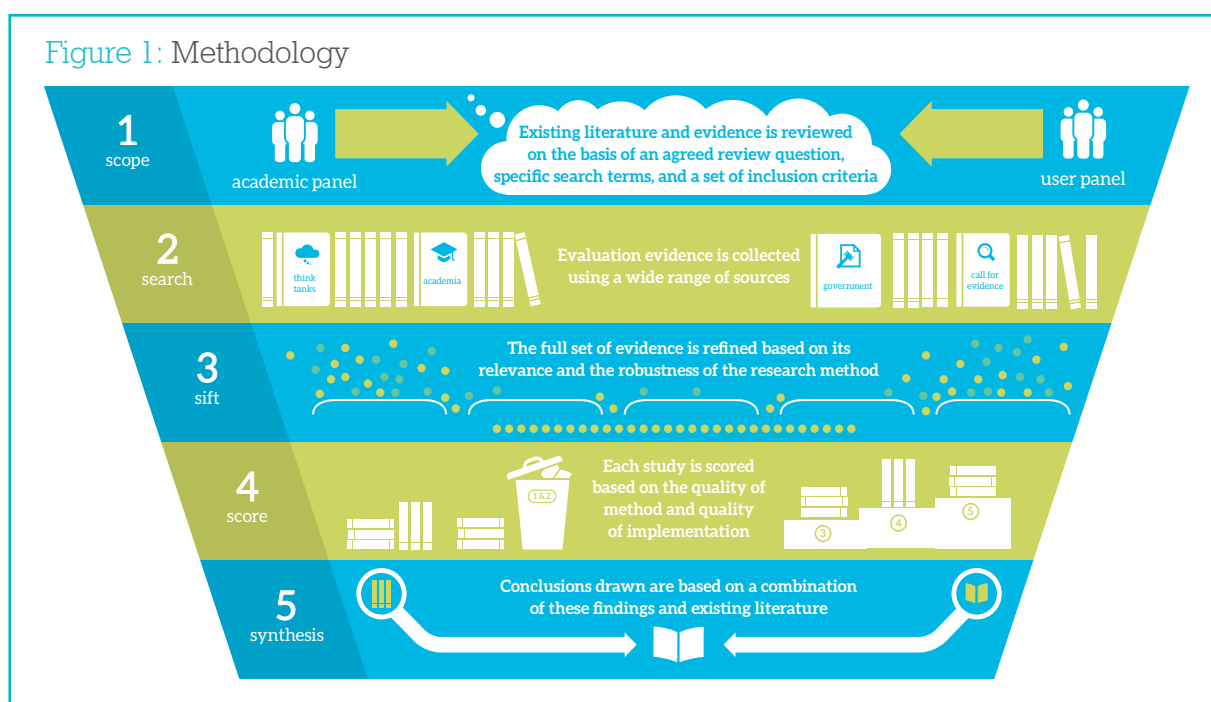
We exclude evaluations that provide a simple before and after comparison only for those receiving the treatment because we cannot be reasonably sure that changes for the treated group can be attributed to the effect of the programme.

We also exclude case studies or evaluations that focus on process (how the policy is implemented) rather than impact (what was the effect of the policy). Such studies have a role to play in helping formulate better policy, forming an important complement to impact evaluations, but they are not the focus of our evidence reviews.

## 05

# Methodology

To identify robust evaluation evidence on the causal impact of collaboration programmes, we conducted a systematic review of the evidence from the UK and across the world. Our reviews followed a five-stage process: scope, search, sift, score and synthesise.



## Stage 1: Scope of Review

Working with our User Panel and a member of our Academic Panel, we agreed the review question, key terms and inclusion criteria. We also used existing literature reviews and meta-analyses to inform our thinking.

## Stage 2: Searching for Evaluations

We searched for evaluation evidence across a wide range of sources, from peer-reviewed academic research to government evaluations and think tank reports. Specifically, we looked at academic databases (such as EconLit, Web of Science and Google Scholar), specialist research institutes (such as CEPR and IZA), UK central and local government departments, and work done by think tanks (such as the OECD, ILO, ippr and Policy Exchange.) We also issued a call for evidence via our mailing list and social media. This search found around 1700 books, articles and reports. A full list of sources and search terms is available online here: [www.whatworksgrowth.org/policies/innovation/evidence-sources](http://www.whatworksgrowth.org/policies/innovation/evidence-sources).

## Stage 3: Sifting Evaluations

We screened our long-list on relevance, geography, language and methods, keeping impact evaluations from the UK and other OECD countries, with no time restrictions on when the evaluation was done. We focussed on English-language studies, but would consider key evidence if it was in other languages. We then screened the remaining evaluations on the robustness of their research methods, keeping only the more robust impact evaluations. We used the Maryland Scientific Methods Scale (SMS) to do this.<sup>17</sup> The SMS is a five-point scale ranging from 1, for evaluations based on simple cross sectional correlations, to five for randomised control trials (see Box 2). We shortlisted all those impact evaluations that could potentially score three or above on the SMS.<sup>18</sup> In this case we found 37 evaluations scoring three and only four scoring four: for examples of evaluations that score three and four on the SMS scale see [www.whatworksgrowth.org](http://www.whatworksgrowth.org).

## Stage 4: Scoring Evaluations

We conducted a full appraisal of each evaluation on the shortlist, collecting key results and using the SMS to give a final score for evaluations that reflected both the quality of methods chosen and quality of implementation (which can be lower than claimed by some authors). Scoring and shortlisting decisions were cross-checked with the academic panel member and the core team at LSE. The final list of included studies and their reference numbers (used in the rest of this report) can be found in Appendix B.

## Stage 5: Synthesising Evaluations

We drew together our findings, combining material from our evaluations and the existing literature.

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<sup>17</sup> Sherman, Gottfredson, MacKenzie, Eck, Reuter, and Bushway (1998).

<sup>18</sup> Sherman et al. (1998) also suggest that level 3 is the minimum level required for a reasonable accuracy of results.



### Box 2: The Scientific Maryland Scale

**Level 1: Correlation of outcomes with presence or intensity of treatment, cross-sectional comparisons of treated groups with untreated groups, or other cross-sectional methods in which there is no attempt to establish a counterfactual.** No use of control variables in statistical analysis to adjust for differences between treated and untreated groups.

**Level 2: Comparison of outcomes in treated group after an intervention, with outcomes in the treated group before the intervention ('before and after' study).** No comparison group used to provide a counterfactual, or a comparator group is used but this is not chosen to be similar to the treatment group, nor demonstrated to be similar (e.g. national averages used as comparison for policy intervention in a specific area). No, or inappropriate, control variables used in statistical analysis to adjust for differences between treated and untreated groups.

**Level 3: Comparison of outcomes in treated group after an intervention, with outcomes in the treated group before the intervention, and a comparison group used to provide a counterfactual (e.g. difference in difference).** Some justification given to choice of comparator group that is potentially similar to the treatment group. Evidence presented on comparability of treatment and control groups but these groups are poorly balanced on pre-treatment characteristics. Control variables may be used to adjust for difference between treated and untreated groups, but there are likely to be important uncontrolled differences remaining.

**Level 4: Comparison of outcomes in treated group after an intervention, with outcomes in the treated group before the intervention, and a comparison group used to provide a counterfactual (i.e. difference in difference). Careful and credible justification provided for choice of a comparator group that is closely matched to the treatment group.** Treatment and control groups are balanced on pre-treatment characteristics and extensive evidence presented on this comparability, with only minor or irrelevant differences remaining. Control variables (e.g. OLS or matching) or other statistical techniques (e.g. instrumental variables, IV) may be used to adjust for potential differences between treated and untreated groups. Problems of attrition from sample and implications discussed but not necessarily corrected.

**Level 5: Reserved for research designs that involve randomisation into treatment and control groups.** Randomised control trials provide the definitive example, although other 'natural experiment' research designs that exploit plausibly random variation in treatment may fall in this category. Extensive evidence provided on comparability of treatment and control groups, showing no significant differences in terms of levels or trends. Control variables may be used to adjust for treatment and control group differences, but this adjustment should not have a large impact on the main results. Attention paid to problems of selective attrition from randomly assigned groups, which is shown to be of negligible importance.



# Definition

By 'R&D', we mean investigative activity undertaken by the private sector (with or without academic participation), which has the objective of improving existing, or developing new, products or processes. Governments carefully define the scope of R&D inputs.<sup>19</sup> Programmes aimed at commercialising R&D aim to assist the generation, diffusion and exploitation of these products and processes.

In this review, we looked at evaluations of a range of grants, loans and subsidy programmes designed to boost R&D. We included in our definition, programmes that provided financial assistance for the purposes of R&D and to support R&D commercialisation and growth, where growth includes: increased private R&D expenditure; growth in number of patents and growth in productivity.

Shortlisted programmes include:

- Innovation-policy schemes providing public funding for innovation projects
- National funds for research in science and technology
- Subsidised government loans for R&D activities
- Regional subsidies to support public and private R&D activities.

As discussed in the introduction, other types of innovation support (e.g. tax credits, other fiscal support mechanisms, and public venture capital support for high tech firms) are covered in a separate innovation review. VC programmes have been covered in our access to finance review.<sup>20</sup>

## Impact evaluation for R&D grants, loans and subsidy programmes

Key to impact evaluation is high quality data for both treated and control groups. Even when high quality data is available (itself a major problem for R&D programmes), to construct a suitable control group we must also be able to identify firms that are similar to participants, but that are not receiving assistance. For example, some R&D programmes are open to all firms in target sectors (or in some

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<sup>19</sup> For example, see <https://www.gov.uk/guidance/corporation-tax-research-and-development-rd-relief#which-costs-qualify-for-rd-relief> (accessed 25 September 2015).

<sup>20</sup> We will also discuss the evaluation of the UK Creative Credits programme in a future review. This programme involves an element of subsidy, but is very different in set-up to the other schemes discussed here.

cases, across the economy), making it difficult to establish treatment and control groups. Other programmes may in principle be open to all, but may then be highly selective in terms of who gets funded.

In the first example, it is hard to observe and control for firms' motivation for taking part in a programme. In the second, it may be hard to control for the way in which support is allocated. Either way, these are examples of a more general 'selection into treatment' problem. Such selection might lead to upward bias (e.g. if high-performing firms who will benefit the most from grants apply) or downward bias (e.g. if poor performers apply). Selection bias is likely to be a big problem for R&D grant and loan programmes if the design of the programme involves targeting of support on the basis of detailed bids.

For all these reasons, firms receiving support from R&D grants and loans will tend to differ on many dimensions from firms that do not get support. Some of these differences will be hard to observe in available data, making it very difficult to construct an appropriate control group. Furthermore, it is unlikely that these underlying differences will be constant over time.

In many circumstances evaluations could, in principle, use randomised control trials to address these concerns over selection. Or at least, the evaluation design could involve randomisation following selection on the basis of some basic 'threshold' criteria. In practice, our review found no examples of evaluations using explicit randomisation to help deal with selection.

Instead, many studies in this review attempt to address these 'selection problems' using variations on difference-in-difference combined with matching or panel fixed effects methods. In these methods, the change in outcome in the 'treatment' firms (those that get support) is compared with the change in outcome in a group of similar control firms (which do not). The control group is constructed to be similar to the treatment group either by matching on observed characteristics or by using control variables. By taking a before-and-after difference, these methods eliminate all fixed unobservable differences between the treatment and control groups. However, as already discussed, there are also likely to be time-varying unobservable differences that lead to success in getting R&D support. These methods cannot account for these underlying factors.

In order to allow for these unobservable factors, and thus more reliably assess the impact of R&D support it is important to exploit some source of randomness in the way that support is delivered. Only five of our shortlisted studies adopt approaches that allow them to try to deal with this problem of selection on unobservables.

For example, study 468 – an evaluation of FONDEYCT programme in Chile, which makes competitive grants to academic researchers and research teams – compares outcomes for some of the successful applicants with those who just missed out on being selected (in the jargon, a 'regression discontinuity design'). The idea is that applicants that just miss out are likely to be similar to applicants that only just succeed; around the threshold, treatment is more or less random. Using the same approach, study 809 looks at the Regional Programme for Industrial Research, Innovation and Technology Transfer in the Emilia-Romagna region in Italy. Since funding was based on the quality of project proposals that were assessed and scored by a committee of independent experts, the authors hoped to minimise (or even eliminate) selection issues by comparing projects that scored just above and below the threshold. For evaluations taking this kind of approach, differences between supported and unsupported organisations may more confidently be attributed to the effects of the programme.

An alternative approach is used by study 1210 which adopts an instrumental variable approach to

examine the effect of various R&D support programmes in Finland. It uses geographic variation in the potential amount of R&D subsidies available by region to explain variation in the support that firms receive. This variation is driven by rules set by international policies, such as the European Union Region Development Fund, and therefore reduces discretion on particular applications. In turn, this means similar firms can end up getting different levels of support depending on where they are currently located – making support ‘quasi-random’ with respect to unobservable firm characteristics. As with the threshold approach described above, in this evaluation differences between supported and unsupported organisations may more confidently be attributed to the effects of the programme.

In addition to these selection problems – which apply to many policy areas – impact evaluation for R&D programmes presents some particularly tough challenges, as we noted earlier.<sup>21</sup> Compared with some other areas of policy, it is harder to monitor outputs and outcomes in this area. What counts as ‘R&D activity’ is not easily measurable in the way that (say) moving into a job is for an employment training programme. A number of studies also use self-reported outcome measures (for instance, reported product and process innovations). These have the advantage of capturing aspects of innovative activity that do not show up in measures such as patents; on the other hand, they may capture some trivial innovations and may be vulnerable to response bias.<sup>22</sup>

The large number of innovation ‘impact pathways’ can also make it difficult to define the full scope of impact and identify suitable impact metrics. While a logic chain from higher R&D spending in a firm to more innovation by that firm can often be established with good data, attributing subsequent changes in firm-level productivity or employment to R&D is less straightforward. These problems are exacerbated if we want to look at the wider, local economy-level impacts for firms that might not themselves be undertaking the R&D (but that benefit from spillovers).

As with our other reviews, the evaluations we identify are able to address some, but not all of these problems. A greater focus on evaluation at the policy design stage will, hopefully, allow future evaluations to do a better job of dealing with more of these issues. For now, however, it is important to interpret the findings from our review with a degree of caution consistent with the quality of the existing evidence base.

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21 Cunningham and Gök (2013) and Cunningham and Ramlogan (2013).

22 Smith (2005).



# Findings

This section sets out the review's findings. We begin with a discussion of the evidence base, and then explore the overall pattern of positive and negative results. After this we consider specific programme features in more detail.

## Quantity and quality of the evidence base

The review initially considered around 1,700 policy evaluations and evidence reviews from the UK and other OECD countries, identified during the initial keyword search.

Following a further high level review, nearly 1,500 were sifted out as not relevant (e.g. because they were theoretical rather than data-based; reviewed non-OECD countries; or because of subject relevance). From the remaining evaluations, we discarded around 130 further evaluations either because they turned out not to be relevant on more detailed review or because they did not meet our minimum standards. Of the remaining studies on innovation policy programmes, this review considers the 42 impact evaluations that covered programmes offering R&D grants and loans.

This is a smaller evidence base than for our first review (on employment training) although roughly comparable to our second and third reviews (on business advice and the impact of cultural and sports projects, respectively), and larger than our reviews of business access to finance, estate renewal programmes and transport investment. This may still be larger than the evidence base for many other local economic growth policies. However, it is a small base relative to that available for some other policy areas (e.g. medicine, aspects of international development, education and social policy).

Table 1 shows the distribution of studies ranked according to the SMS. We found only five studies<sup>23</sup> that used credible quasi-random sources of variation (so scored 4 on the SMS). The remaining 37 studies scored 3 on the SMS, and use variations on matching techniques combined with difference-in-difference approaches or panel fixed effects estimation. The techniques applied in these studies mean that we can be reasonably confident that they have done a good job of controlling for observable characteristics of firms (for example: firm age; size; sector) that might explain differences in firm outcomes. However, it is likely that unobservable characteristics that vary over time may still be

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23 Studies 450, 468, 809, 1210 and 1212

affecting the results. Given that selection issues are a particular concern with R&D grants and loans, this means that our findings have to be used with some care.

**Table 1:** Studies ranked by SMS for implementation.

SMS score	Number	Reference number
3	37	388, 392, 397, 402, 407, 421, 424, 438, 449, 460, 466, 467, 471, 472, 479, 490, 492, 495, 499, 500, 505, 507, 509, 514, 516, 517, 518, 524, 526, 527, 530, 536, 1153, 1205, 1209, 1211, 1318
4	5	450, 468, 809, 1210, 1212
<b>Total</b>	<b>42</b>	

## Type and focus of programmes

Broadly speaking, we found three types of intervention. The first group covers finance to universities and public research labs to fund R&D; the second group involves direct support to firms; the third, related group, involves providing finance through intermediary agencies such as VC businesses (either public VC or co-finance with private sector VC). As noted above, VC programmes have been covered in our access to finance review and will be discussed separately in a future review.

Many of the articles evaluated consider multiple policies, whilst others focus on more specific programmes. Of the evaluations:

- Twelve studies look at R&D subsidy schemes that are primarily targeted at private firms.
  - Seven of these 12 consider specific programmes in Italy. Studies 392 and 809 investigate the impact of the Regional Programme for Industrial Research, Innovation and Technological Transfer that aimed to foster industrial research and precompetitive development by firms in the Emilia-Romagna region. A further two studies look at the DOCUP programme in Piedmont that combines a subsidised loans scheme with R&D grants.<sup>24</sup> Studies 479 and 509 look at various schemes that explicitly supported new-technology based firms, while study 524 evaluates the Special Fund for Applied Research.
  - The remaining five evaluations look at different programmes in Chile, Finland, New Zealand, Spain and Israel, respectively. Study 467 looks at the National Fund for Technological and productive Development in Chile that supported demand-driven R&D by private firms. Study 527 evaluated the impact of the Technology New Zealand programme. Study 518 looks at the largest R&D subsidy programme in Israel that offers grants or loans, depending on the commercial success of the project. Two further studies consider the effect of various funding sources, mainly R&D grants, available to firms in Spain and Finland, respectively.<sup>25</sup>
- Ten studies look at subsidy programmes that aim to create or enhance collaboration between firms or between firms and other organisations such as universities.
  - Three of these ten consider Japanese programmes supporting research consortia<sup>26</sup> or industrial clusters.<sup>27</sup>

24 Studies 472 & 1153.

25 Studies 471 & 1210.

26 Studies 397 & 449.

27 Study 424.

- Three studies evaluate the impact of the EU Eureka programme that promotes cross-border joint ventures between private companies. One of these studies looks at cross-country differences<sup>28</sup> while two investigate the impacts for Denmark and France, respectively.<sup>29</sup> A fourth study looks at the User-friendly Information Society, another EU programme with similar objectives to Eureka.<sup>30</sup>
- The three remaining studies evaluate various R&D subsidy programmes that are meant to foster collaboration in Belgium, Denmark and Germany, respectively.<sup>31</sup>
- Five studies consider policy measures that are primarily targeted at academic or research institutions.
  - Of these five studies, two look at specific legislation in the US. Study 402 investigates the effect of the Bayh-Dole Act that allowed universities to retain royalties for patents funded with public subsidies. Study 536 considers the Experimental Program to Stimulate Competitive Research, a national initiative to enhance research competitiveness in specific US states.
  - Two further studies consider the effect of grants from the National Institutes of Health on various research institutions in the US.<sup>32</sup>
  - The fifth evaluation, study 468, focuses on the impact of the National Science and Technology Research Fund (FONDECYT) in Chile.
- The remaining 15 evaluations use datasets that include information on various unnamed policy programmes.
  - Two of these 15 studies consider an international comparison between programmes in Germany and Finland or Germany and Belgium, respectively.<sup>33</sup>
  - Four studies consider various programmes in Spain.<sup>34</sup>
  - Two studies focus on grant and collaboration programmes in Germany.<sup>35</sup>
  - One study looks at subsidy programmes in Ireland<sup>36</sup> and another at Ireland and Northern Ireland.<sup>37</sup>
  - One looks at multiple R&D support programmes for firms in New Zealand.<sup>38</sup>
  - The remaining four studies evaluate different policy measures in Belgium, the United Kingdom, the US and Norway, respectively.<sup>39</sup>

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28 Study 466.

29 Studies 490 & 530.

30 Study 450.

31 Studies 438 (Belgium), 1209 (Germany) & 421 (Denmark).

32 Studies 517 & 1212.

33 Studies 407 & 460.

34 Studies 388, 492, 505 & 1205.

35 Studies 500 & 516.

36 Studies 507.

37 Study 514.

38 Study 1318.

39 Studies 495, 499, 526 & 1211.

## The effects on R&D, innovation and business growth

When considering the effects of programmes we distinguish between evaluations that consider:

- The effect on R&D spending (i.e. on inputs in to the innovation process);
- The (direct) impact on innovative activities (such as patenting and reported product/process innovations);
- The (indirect) impact on economic outcomes (productivity, employment and so on).<sup>40</sup>

Results for each of these three categories are reported in table 2 and explained further below. Table A1 in the appendix reports results for individual outcomes.

**Table 2:** Overall findings for broad outcome categories

Outcome category	Number	Works	May help	Mixed results	Doesn't work	Harmful	Share of positive
R&D expenditure	18	397, 449, 460, 471, 495, 530, 1210, 1211		388, 407, 505, 507, 518, 809, 1153, 1205	467	536	8/18
Innovation outcomes	16	397, 402, 407, 421, 424, 449, 499, 514, 1212, 1318	467	516, 1209	500, 524, 526		10/16
Firm performance	17	424, 450, 490, 409, 526, 527, 530, 1318	467, 1210	421, 466, 479, 809, 1153	472, 524		8/17

We use this breakdown for a number of reasons. First, it is important to check that R&D grants have the expected positive effect on R&D itself, especially when this is a scheme objective. Second, we want to know whether increased R&D spend feeds through to measures of innovation. As set out in section 1, to the extent that these programmes do not crowd out private sector R&D, we might reasonably expect the direct effects of these programmes to be felt on innovation outcomes. Third, when it comes to *local* economic growth, we also want to know if changes in innovative activity feed through to broader economic outcomes such as firm productivity and employment.<sup>41</sup>

In terms of understanding whether there is a link from programme to firm performance, we should have most confidence in evaluations that consider the link from increased R&D spend, through innovation, to improved firm performance. Unfortunately, only one evaluation (study 467) does this. A further five evaluations consider both innovation and firm performance measures (but not R&D)<sup>42</sup> while another four consider both R&D spend and firm performance (but not innovation).<sup>43</sup> We should worry that studies that can't show these links at work may be picking up something else about the firms taking part in the programme (see the discussion on evaluation challenges above).

40 Note that some of the evaluations cover more than one outcome, so category counts do not sum to the total count.

41 Given the difficulties in measuring innovation outcomes, it is possible that studies that consider both could find positive effects on employment with no matching effect on innovation outcomes. In practice, this is not an issue for the evaluations that we consider in this review.

42 Studies 421, 424, 524, 526 and 1318. We ignore Study 472, which considers a subsidized loan scheme and uses as its innovation measure increased firm debt. We discuss this study below.

43 Studies 530, 809, 1153 & 1210.



## Effects on R&D

**Support can positively impact R&D expenditure, although effects are not always positive. Evidence on the extent to which public support crowds out private investment is also mixed.**

There are 18 evaluations that consider the effect of programmes on R&D spending. Eight of these find a positive effect on R&D spending, while for another eight the evidence is more mixed. One evaluation finds zero effects while one even finds that the effect is negative. On the face of it this pattern of results is surprising given that the immediate impact of these programmes is supposed to be on firms' R&D spend (a specified programme objective for all 18 of these programmes).<sup>44</sup>

If we take the result at face value one explanation for this result is that these programmes crowd out private sector R&D. In practice, we know that some schemes support firms, others support universities and some support public-private collaborations, so any actual crowding out may be more limited than this. It is also possible that public spending accounts for a small percentage of total R&D spending in supported firms, which might make it hard for some evaluations to detect relatively small positive effects that are statistically significant.

Seven of the evaluations that have information on private funded R&D (rather than total R&D) are able to look at this issue directly. These seven studies therefore provide some reassurance on the extent of crowding out – in fact finding evidence of small 'crowding-in' effects, that is, public R&D spending encourages further private sector R&D activity.<sup>45</sup>

In turn, those results are consistent with the wider econometric literature, and with economic theory, which emphasises the need for government to partially fund firms' discovery and commercialisation costs. A recent overview that looked at 74 econometric studies found evidence of public R&D 'crowding in' for 38 studies, 'crowding out' for 17 and no effect in the remaining 19. Within this set, the largest grants were most likely to be linked to displacement of private sector R&D.<sup>46</sup> Overall, on the basis of the available evaluation evidence, the extent of crowding out remains an open question and it would be good to see further evaluation work that considers this issue.

## Effects on Innovation

**R&D grants and loans can positively impact innovation, although effects are not always positive. The effects differ across types of innovation and are weaker for patents than for (self-reported) measures of process or product innovation.**

Less than half of the evaluations (19 out of 42) look at innovation outcomes. In this section, we start by focussing on the 16 evaluations that consider patents or self-reported innovation (in terms of either products or process). The remaining three studies consider less standard measures of innovation and are discussed separately, further below.

44 For a further 12 evaluations, 'increased R&D' is a stated programme outcome but is not covered in the evaluation. There is no particular reason to think that this should distort the overall finding although, as always, we would ideally like to see all programmes evaluated against their stated objectives.

45 Studies 471, 495, 505, 507, 518, 1210 & 1211.

46 See García-Quevedo (2004) and our discussion below. Lerner (2002) and Guellec and Van Pottelsberghe De La Potterie (2003) provide further discussion.

## Effect on patents, product or process innovation

Of these 16 studies, ten find consistently positive effects of the programme on at least one of these innovation outcomes. One study find positive effects on one innovation outcome, but zero effects on others. A further two studies also found mixed results for the particular innovation outcome considered.<sup>47</sup> Finally, three studies found that the programme had no effect on innovation.<sup>48</sup> On balance, this suggests that for most programmes there is at least some evidence of positive effects on innovation, although there is only strong evidence of positive effects in around half of the evaluations.

Results for individual innovation measures are broadly in line with these overall findings. Of the 12 evaluations that look at patents, six find positive effects, one reports mixed findings and five find no effect. For the six evaluations that consider (self-reported) product innovation results break down similarly with four finding positive effects, one mixed and one zero. Finally, four out of the five evaluations that consider (self-reported) process innovation find positive effects, with one mixed.

It could be argued that the patent results urge some caution in terms of the overall finding of positive effects. Patents are the most objectively measured innovation outcome and five out of 12 of the evaluations find no effect on patents. This means that the overall results are somewhat driven by the more positive findings for the less objective self-reported innovation measures.

However, as discussed extensively in the academic literature, patents may be objectively measured, but they only capture one aspect of the innovation process. As recent research shows, only a minority of UK firms patent, so some patents may not be using an appropriate success measure.<sup>49</sup> Self-reported innovation measures have the great advantage of capturing aspects of innovative activity - new ways of working, as well as new products and services - that do not result in patents or other formal kinds of IP protection. On the other hand, some self-reported innovations may turn out to be trivial, and as discussed earlier, it is possible that firms with something to report may be more likely to respond to the survey. Finally, it is also important to note that almost half (18 out of 42) of the evaluations in our shortlist cover sectors where patenting is common, such as engineering, high-tech manufacturing or biotech.

## Effect on other innovation outcomes

So far, we have focussed on evaluations that look at the impact on innovation using information on patents or on self-reported product or process innovation. Some evaluations consider a range of alternative innovation measures and we consider the findings from these here.<sup>50</sup>

Two studies consider alternative measures of innovation outcomes. Study 468 evaluates the FONDEYCT scheme in Chile, and looks at how grants to researchers affected the quantity and quality of academic publications. It finds a positive significant impact on quantity of outputs among researchers receiving a grant, but zero effect on quality (as measured by citations for publications). Study 526 tests whether US R&D subsidies (and tax credits) have influenced biotech cluster formation, as measured by numbers of star scientists. It finds only a weakly significant positive effect

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47 For example, results may vary across different econometric specifications, across different samples or across firm size.

48 We found no evaluations that reported negative effects on innovation outcomes.

49 Hall et al (2010).

50 Two evaluations (of the same scheme) – studies 472 and 1153 – use increases in debt as a way of capturing the impact of loans that do not cover 100% of the project cost. If partially subsidized firms use other sources of capital (for example, bank loans) to finance the remaining amount of the investment then increased debt provides an indirect way of capturing the effect on R&D expenditure. However, because debt can increase for other reasons, we prefer to discuss these studies below when we consider the effect on other economic outcomes.

on the reallocation of (old) star scientists which does not persist in the long term. There is no evidence that these programmes trigger incumbent scientists to become more successful (i.e. create new stars).<sup>51</sup>

Three studies look at effects on the innovation process, rather than outcomes. Study 392 looks at the impact on inter-firm collaboration of a programme in the Emilia-Romagna region that aimed both to increase R&D and to improve collaboration between local manufacturing firms. Interestingly, while supported firms reported improvements to organisational practices, both in R&D and more generally, they were *less* likely to co-operate with other local firms. A possible explanation is that firms' desire to protect innovations from competitors is stronger than perceived gains from collaboration. This highlights an important tension between the various aims of innovation policy: boosting individual firms' innovation capabilities may make collaboration between (some of) those firms less likely. This matters given that many grant schemes – especially EU programmes – require collaborative applications.

Study 438 also looks at collaboration, evaluating how Belgian firms responded to EU-funded R&D subsidies and technology transfer initiatives. It finds mixed results. For firms with their own R&D staff there is a positive effect on links to universities, while for others firms the positive effects are for links to public research labs.

Study 424 also considers a scheme that aims to boost collaboration – in this instance for the Japanese Industrial Cluster Programme (ICP), which combines direct R&D support with measures to boost inter-firm linkages and networks. It finds that programme participants are significantly more likely to engage in collaborative networks with universities, have improved self-assessed technological capabilities and higher reputations. This evaluation also suggests that larger and more research-active firms are most likely to join this type of programme.

## Effects on Economic Outcomes

**R&D grants and loans can positively impact productivity, employment or firm performance (profit, sales or turnover). There is some evidence that support is more likely to increase employment than productivity.**

As with innovation outcomes, less than half of the evaluations (19 out of 42) look at effects on economic outcomes. In this section, we start by focussing on the 17 evaluations that consider productivity, employment or some measure of sales, turnover or profit. The first two of these provide the most direct evidence of the potential impact of these programmes on local economic growth. We consider sales, turnover and profits together, and refer to these as measures of 'firm performance'. We view these as a way of capturing changes to firm performance that will be of interest to businesses. We also hope that these measures may be indirectly capturing the effect of underlying increases in productivity, or may be associated with increases in employment. Some of these evaluations (plus the remaining two out of the 19) consider a variety of other economic outcome measures and are discussed separately, further below.

<sup>51</sup> Although note that unlike most of the other shortlisted studies, this evaluation is looking at area-level outcomes, where it may be harder to detect a clear link back to grants – as these go to individual firms, universities, or other research institutes.

## Effect on productivity, employment and firm performance

Of the 17 studies that consider productivity, employment or firm performance (sales, turnover or profit), eight find consistently positive effects of the programme on at least one of these outcomes. Three studies find positive effects on both employment and firm performance; two of these find no effect on productivity.<sup>52</sup> A further five studies found (at best) mixed results for the economic outcomes considered.<sup>53</sup> Finally, two studies found that the programme had no effect.<sup>54</sup> On balance, this suggests that for most programmes there is at least some evidence of positive effects on economic outcomes, although there is only strong evidence of positive effects in about half of the evaluations.

Results for individual economic measures are broadly in line with these overall findings. Of the nine evaluations that look at productivity, four find positive effects, one reports mixed findings and four find no effect. For the twelve evaluations that consider some measure of firm performance (sales, turnover or profits), seven find positive effects and three zero. Finally, six out of nine evaluations found positive effects for employment with the remaining three reporting mixed or zero effect.

Taking the results for individual outcome measures at face value suggests that R&D grants are somewhat more likely to improve employment (six out of nine) than to improve productivity or firm performance (sales, turnover or profit). This is somewhat puzzling, as one might expect changes in the latter to underpin improved employment performance. Given the more ambiguous results for patenting and for R&D spending itself, we could speculate that in at least some cases, R&D grants and loans might be used directly to hire more workers, rather than fund research or innovative activity.

## Effect on other economic outcomes

So far, we have focussed on evaluations that look at the impact on productivity, employment or firm performance. A number of evaluations consider a range of alternative economic outcome measures and we briefly consider the findings from these here.<sup>55</sup>

In addition to the effect on total sales, the effect on exports may be of interest - either because exports are an explicit policy objective or because it is hoped that positive effects on export sales do not come at the expense of other local firms.<sup>56</sup> The two studies that consider this both show positive effects.<sup>57</sup>

Data on labour costs may capture underlying increases in productivity or employment. Four studies look at labour costs or wages. Three find no positive effects – either on wages (503 and 526) or on wages and labour costs (809). In contrast, study 524 shows that average labour costs in small and medium sized firms increase one year after grants are received, but that this effect does not persist. However, the evaluation finds no effects on productivity, employment or sales which points to one of the problems of using data on labour costs as an indirect proxy for productivity or employment effects.

52 Studies 467, 1210 and 1318. Studies 467 & 1210 find no productivity effect.

53 Studies 421, 466, 479, 809 & 1153. For example, results may vary across different econometric specifications, across different samples or across firm size.

54 Study 472 found no effect on productivity nor on sales, turnover or profit. It did find an effect on assets as discussed further below. Study 524 presented zero effects for all three standard outcomes and found mixed effects for average labour costs. We found no evaluations that reported negative effects on evaluation outcomes.

55 None of the evaluations look at land or property prices, but we could easily imagine a programme that induces sufficient firm starts and/or FDI to influence land and property markets.

56 It is still possible, of course, that increased export sales come at the expense of other exporting firms in the local area that previously served the same export markets.

57 Study 467 shows increases in exports as a share of total sales; Study 490 shows increases in total export sales.

Data on firm assets may also capture the effect of programmes if commercialisation requires investment in capital. Three studies consider the impact on fixed or tangible assets, generally showing mixed results. Looking at both outcomes, study 472 finds that subsidised loans had a positive effect on fixed assets but a zero effect on tangible assets, while grants have a positive effect on both types of assets. Study 1153 finds that the same programme has no effect on long term debt. This result is consistent with study 1210 for the impact of grants on fixed assets. In contrast, study 472 finds that grants as well as subsidized loans increase short term debt levels. Overall, these findings suggest that support does not directly translate in to bigger stocks of fixed or tangible assets. Whether this is an issue depends, of course, on whether further investment is needed to commercialise any innovations that result from programme support.

A number of evaluations consider a range of further miscellaneous measures that might capture effects on firms receiving support. Two studies look at value added with one finding positive effects (study 492), the other no effect (study 1153). Two other evaluations looking at alternative outcome measures (cash-flows, working capital or service costs) find zero effects.<sup>58</sup>

Finally, two evaluations (studies 517 and 526) consider the effect on new, rather than existing, firms in the bio-tech sector in the US. Both report positive effects on the creation of new firms in this sector. Study 517 stresses that effects are particularly pronounced when funding goes to private companies rather than research institutes or universities.

### Linked analysis on R&D, Innovation and Economic Outcomes

**Relatively few evaluations consider more than one element of the chain from increased R&D spend, through innovation, to improved firm performance. Results from these studies are mixed.**

As discussed above, relatively few studies consider more than one element of the chain from increased R&D spend, through innovation, to improved firm performance. The one evaluation (study 467) that looks at all three elements finds no effect on R&D spend, and no effects on patents or product innovation. It does, however, find positive effects on self-reported process innovation. Somewhat puzzlingly, this does not show up in increases in productivity where the study finds zero effects. It does, however, find weakly positive effects on employment, sales growth and exports.

Among the five studies that look at both innovation and economic outcomes, only one finds consistently positive effects on both.<sup>59</sup> The second finds positive effects on patents, but mixed effects on employment and no effect on profits.<sup>60</sup> The third reports that R&D subsidies had a positive effect on employment but no effect on patents.<sup>61</sup> A fourth finds no effect across all outcome variables considered: patents, employment, productivity and sales.<sup>62</sup> A fifth finds no effect on patents, but positive effects on self-reported innovation and on sales due to new products/services.<sup>63</sup>

The four evaluations that look at both R&D spending and economic outcomes (but not innovation) show a similar pattern. Again, there is one study that finds consistently positive effects in terms of

58 Studies 809 & 1153.

59 Study 424.

60 Study 421.

61 Study 526.

62 Study 524.

63 Study 1318.

both increased R&D and positive employment and productivity effects.<sup>64</sup> A second evaluation (study 1210) similarly finds positive effects on R&D and employment (as well as sales), although it differs in finding no effect on productivity. The remaining two studies<sup>65</sup> find mixed effects on R&D spending as well as on employment and sales, respectively. These are either due to heterogeneous effects across firm size or credit ratings – differences that we discuss further below.

### Short versus long run effects

**Relatively few evaluations consider the timing of effects. There is a lack of studies considering long-term impacts of interventions (ten years plus). However, the small number of studies that are able to consider the time profile of effects suggest that effects get weaker (not stronger) over time.**

One concern with the results reported so far is that it might take time for effects to emerge. R&D investments are inherently risky and might pay off, if at all, only in the long run. None of the evaluations that we consider are able to assess the effects over time horizons of, say, ten years or more. Interestingly, the small number of studies that are able to consider the time profile of effects suggest that effects get weaker (not stronger) over time. In fact, if anything, the opposite appears to be the case.

The seven studies that have looked at the persistence of the effect of R&D subsidies focus on short- and medium-term time horizons only: typically, first to fourth year after project completion (or receiving the grant). Among these seven studies, three find that the subsidy was only or mostly effective in the first year after completion<sup>66</sup> and had a smaller impact in terms of magnitude and significance thereafter. Depending on the outcome considered, the four remaining studies show significant positive effects for up to two years but no longer.<sup>67</sup>

### Differences across firms

**R&D subsidies are more likely to improve outcomes for small to medium size companies than for larger ones.**

The effects presented above can mask considerable heterogeneity across different types of firms. Such heterogeneity is obviously of interest to policy makers deciding whether to target scarce funds at particular types of firms.

The most frequently studied heterogeneity relates to firm size. Twelve evaluations consider whether results differ for small and medium (SME) sized firms as opposed to large firms. Seven of these studies find that SMEs are the only firms to show positive effects of support,<sup>68</sup> while a further two studies find effects are considerably larger for SMEs.<sup>69</sup> Only three of the 12 studies find that the size of companies does not matter for explaining the existence or strength of the effect of the programme.<sup>70</sup>

Overall, therefore, the evaluation evidence suggests that R&D subsidies are more likely to improve outcomes for smaller companies. This is in line with arguments from the wider literature that suggest

64 Study 530.

65 Studies 809 & 1153.

66 Studies 524, 527 & 530.

67 Studies 421, 472, 526 & 1153.

68 Studies 421, 505, 516, 524, 527, 809 & 1205.

69 Studies 499 & 1153.

70 Studies 438, 530 and 1318.

that smaller, younger firms face stronger information asymmetries on the capital markets, and are therefore more financially constrained. As a result, R&D subsidies provide these innovative small firms with a means to conduct projects that would have been unprofitable when privately financed.<sup>71</sup> Interestingly, in line with this suggestion, Study 1153 not only finds larger positive effects for smaller firms, but also for the ones that have lower credit ratings (perhaps because they are both smaller and younger).

Alternatively, the larger effects for small firms can be explained if R&D activities are associated with initial sunk costs that are harder to finance for smaller companies. As a result, the provision of R&D subsidies might help these companies to surpass this threshold and conduct marginally profitable projects.<sup>72</sup>

## Programme design

Innovation programmes such as these are in many ways ‘experimental policy’. Governments seek to encourage the development of new ideas, products and processes, and their diffusion into society. *Which* ideas and products will succeed is inherently unknowable, and some failures are inevitable. This implies that innovation strategy should be seen as a process, where rule-setting, governance and management are more important than any given policy. Policymakers need to test and try out various approaches, with good systems in place to build on successful initiatives and shut down failures.<sup>73</sup>

A first step in this process is the assessment of performance of programmes against programme objectives. We consider this issue below. Evaluation should also provide a mechanism for learning from past programme performance – particularly if we are able to identify policy design elements that appear to be correlated with success. R&D grants, subsidies and loan programmes will tend to share a number of common features. Unfortunately, the evaluations covered here are frustratingly limited in their discussion of programme design details. Eligibility criteria and timescales, for example, are not mentioned in a majority of cases. To the extent that we are able to classify programmes by design features this section also considers whether these features appear to affect policy success.

## Programme objectives and outcomes

**Many programmes are not evaluated against stated policy objectives. Perhaps not surprisingly, there is some evidence that programmes perform better against stated objectives, although it is unclear what specific policy design elements - beyond simply targeting an outcome - might explain this better performance.**

As with several previous reviews, in our studies stated objectives and measured outcomes don’t perfectly align. Innovation policies are often designed with multiple objectives in mind; some of these are less easy to evaluate than others; and in other cases the evaluators may pay little attention to the original policy rationale.

We find 15 instances where a given programme objective is not covered in the evaluation (worrying, in twelve a stated objective is to ‘increase R&D’). We also find 20 instances where economic outcomes *are* included in the evaluation, but do not appear to be part of the original programme rationale (at least as described in the study). It should be noted that along with the many other evaluation

71 See for example, the discussion on p. 126 of Study 809.

72 See for example, the discussion on p. 14 of Study 505.

73 Jaffe (1996), Rodrik (2004) and Lerner 2009.

challenges, the disconnect between programme rationale and outcome evaluated makes clean evaluation harder.

Turning to evaluations that do evaluate outcomes directly related to programme rationale, the most straight forward cases relate to increased R&D and to innovation outcomes. For R&D spending, all 18 studies that consider this outcome have it as a programme objective and similarly for the 19 studies that consider innovation outcomes. The results discussed above are, therefore, still relevant here: around 50% of evaluations suggest positive outcomes against objectives for R&D spending and similarly for outcomes against innovation objectives.

The picture is more mixed when it comes to economic outcomes. The majority of these studies evaluate the effect on outcomes that are not explicit policy objectives (at least according to the evaluation material available to us). When we focus on studies that evaluate outcomes directly related to the programme rationale results are generally more positive than for the set of evaluations as a whole. For example, for productivity four out of seven studies now show consistently positive results (as opposed to four out of nine overall); while for other outcomes all four studies that evaluate against programme objectives find consistently positive results. Only five studies look at programmes specifically focussed on firm performance (sales, turnover or profit) with three out of five consistently showing positive results (as opposed to 6/11 overall). Finally, the two evaluations where employment is both a programme rationale and the outcome evaluated find mixed and positive results.

The most obvious interpretation of these findings is that schemes that specifically target particular outcomes may be slightly better at achieving those outcomes. Unfortunately, looking at the information available to us in the evaluations it is unclear what *specific* features of schemes might explain this greater success rate (beyond simply general orientation towards a target). It's also important to note that for many of the other evaluations, improving economic outcomes is a scheme objective, as well as raising participants' R&D spending and innovative activity. In these cases, the disconnect between evaluated outcome and programme rationale simply reflects the fact that poor data availability forces the evaluation to rely on a proxy outcome to capture impact on the programme objective (for which suitable data is not available). Overall, while these results are interesting, we think they highlight the need for a focus on which aspects of programme design may help improve delivery against objectives. It is to this issue that we now turn.

## Differences across programme types

**Programmes that emphasise public-private collaboration tend to perform better than those that just support private firms (as well as those where the programme focus is unclear). Encouraging collaboration might have an additional positive effect on the likelihood that an R&D support programme generates positive effects on outcomes of interest.**

We identified four broad programme types depending on whether the evaluation covered a programme that supported private companies; supported academic and research institutions; or specifically encouraged and supported collaboration. A fourth category covered miscellaneous R&D grant and loans programmes. There is notable variation across the effectiveness of these four broad programme types (see table A2 in the appendix for more detail).



The small number of schemes aimed at academic and research institutions makes it difficult to identify any trends (the one study that looks at R&D finds no effects, while the two studies that look at innovation outcomes both find positive effects).

The more interesting comparison is between the collaboration schemes and the schemes aimed only at private companies. On balance, the former tend to perform better than the latter. The three evaluations that consider the effects of collaboration programmes on R&D spend consistently find positive effects. In contrast only two out of six find positive effects for the private firm schemes. For innovation outcomes the comparison is four out of five positive (for collaboration) as opposed to one out of two (for private firms). Finally, for economic outcomes four out of six are positive (for collaboration) compared to four out of nine (for private firms). The collaboration schemes also do well relative to the miscellaneous schemes.<sup>74</sup>

Taken at face value, this suggests, that encouraging collaboration might have an additional positive effect on the likelihood that an R&D support programme generates positive effects on outcomes of interest. It is important to note, however, that this finding is based on only a small number of studies and that most of the studies considered cannot fully control for the fact that companies participating in collaborative schemes actively choose to apply for this funding and are therefore most likely different from companies that do not. Other schemes to encourage collaboration may also be equally, or even more, cost-effective.<sup>75</sup>

## Sector targeting

**Programmes that target particular production sectors appear to do slightly worse in terms of increasing R&D expenditure and innovation.**

In terms of programme design the only other feature on which we consistently have more detail relates to the sector targeting of the programme (table 4). Most programmes, 24 of the 42, claim to be sector-neutral. 15 target particular production sectors, while the remaining three target academic research. If we focus on the group of programmes that target particular production sectors versus those that are sector-neutral we do see some differences between programmes. The most marked of these is with respect to the impact on R&D. For the sector neutral schemes, six out of ten studies show a positive effect of R&D in contrast to only two out of seven for the targeted programmes. The difference is smaller – but goes in the same direction – for innovation: with five out of eight positive for non-targeted in contrast to three out of six for targeted. Finally, for economic outcomes this pattern is partially reversed – three out of five of the targeted programmes have positive effects, while only four out of eleven of the non-targeted programmes. That said, the non-targeted programmes look a little better in terms of showing mixed results (some of which will be positive).

On balance it would seem that targeted programmes do slightly worse in terms of R&D expenditure and innovation outcomes – the areas where we would expect to see the direct impacts of support. The fact that the pattern is reversed for economic outcomes once again raises a puzzle about the

<sup>74</sup> There are three evaluations (studies 407, 492 and 500) that consider evidence for multiple schemes where we know that some components support collaboration. We have classified this as miscellaneous for the purposes of this section. Given that results for these evaluations are predominantly positive (study 407 mixed for R&D, positive for patents; study 492 positive for value added; study 500 zero for patents) reclassifying them as collaboration would somewhat strengthen our conclusions.

<sup>75</sup> We will consider these issues further in a companion report on programmes aimed at supporting collaboration.

ability of these programmes to improve economic outcomes without affecting innovation (see the discussion above).

In terms of the more detailed targeting, if any pattern emerges it is that schemes aimed at Engineering-based/high-tech manufacturing do slightly better. However, given the small sample sizes involved, and the degree of fuzziness in terms of the classification of schemes, we do not think it makes sense to push these results broken down by targeted sector results, further.

**Table 4.** Sector targeting of R&D grants and subsidies.<sup>76</sup>

Sector	Number	Reference number
Academic Research	3	402, 468, 536
Engineering-based/ high-tech manufacturing	6	388, 397, 449, 479, 509, 518
Manufacturing	3	505, 507, 524
Biotech	2	500, 526
Scientific / Knowledge Intensive	4	438, 450, 1205, 1212
Sector neutral	24	392, 407, 421, 424, 460, 466, 467, 471, 472, 490, 492, 495, 499, 514, 516, 517, 527, 530, 809, 1153, 1209, 1210, 1211, 1318
<b>Total</b>	<b>42</b>	

### Automatic versus Competitive Schemes

Most of the papers for which we could identify specific schemes usually describe the selection process as involving some kind of committee, evaluation commission or group of independent experts that considered the “quality” of the project proposal. Unfortunately, this does not necessarily imply that there was actual competition for funding. For example, in Germany, many grant programmes are not oversubscribed and all projects get funded eventually.<sup>77</sup> Even if there is some oversubscription, programmes may not be chosen on a competitive basis, but instead funding may depend, for example on political preferences for certain technology fields.

Only two evaluations (studies 479 and 509) directly compare automatic versus competitive subsidies. Both conclude that only the competitive subsidies have positive effects (in both cases on productivity). This provides some evidence that competitive allocation may fare better than automatic – at least for subsidies. This is a question we revisit in our companion report on tax credits.

<sup>76</sup> Review 514 – impact on manufacturing industry assessed (but policy neutral). Review 517 – impact on biotech industry assessed (but policy neutral).

<sup>77</sup> For example, the first few rounds of the ZIM – Zentrales Innovations Programm Mittelstand (one of the biggest innovation programmes for SMEs in Germany with an annual budget of around half a billion euro) has, to date, funded nearly all projects.



# Summary of findings

## What the evidence shows

- R&D grants, loans and subsidies can positively impact R&D expenditure, although effects are not always positive.
- R&D grants, loans and subsidies can raise innovative activity in recipients, although again effects are not always positive. The effects differ across types of innovation, and are weaker for patents than for (self-reported) measures of process or product innovation.
- R&D grants, loans and subsidies can positively impact productivity, employment or firm performance (profit, sales or turnover). There is some evidence that support is more likely to increase employment than productivity.
- R&D grants, loans and subsidies are more likely to improve outcomes for small to medium-size companies than for larger ones. In part this may be because for larger firms, public support makes up a relatively small amount of overall R&D spend, so positive effects are harder to detect. Smaller firms may also be more likely to formalise processes in anticipation of, or response to, a grant, so that some innovation-related spend is reclassified as R&D.
- Programmes that emphasise collaboration perform better than those that just support private firms (as well as those where the programme focus is unclear). Encouraging collaboration might have an additional positive effect on the likelihood that an R&D support programme generates positive effects on outcomes of interest.
- Programmes that target particular production sectors appear to do slightly worse in terms of increasing R&D expenditure and innovation, compared to those that are 'sector neutral'.

## Where the evidence is inconclusive

- Evidence on the extent to which public support crowds out private investment is mixed.

## Where there is a lack of evidence

- There is little impact evaluation evidence on key aspects of programme design, such as eligibility criteria and targeting programmes by firm size.

- Relatively few evaluations consider the timing of effects. In particular, there is a lack of studies considering long-term impacts of interventions (ten years plus). However, the small number of studies that are able to consider the time profile of effects, do not suggest that programme effects get stronger over time.
- Relatively few evaluations consider more than one element of the ‘chain’ from increased R&D spend, through innovation, to improved firm performance. Results from these studies are mixed.
- Programme spend and operational cost data is rarely available to evaluators. This makes it very hard to assess the cost-effectiveness of public R&D grants and subsidy interventions.

## How to use this review

This review considers a specific type of evidence – impact evaluation. This type of evidence seeks to identify and understand the causal effect of policy interventions and to establish their cost-effectiveness. To put it another way they ask ‘did the policy work’ and ‘did it represent good value for money’?

The focus on impact reflects the fact that we often do not know the answers to these and other basic questions that might reasonably be asked when designing a new policy. Being clearer about what is known will enable policy-makers to better design policies and undertake further evaluations to start filling the gaps in knowledge.

## Supporting and complementing local knowledge

This evidence review does not address the specifics of ‘what works where’ or ‘what will work for a particular locality’. An accurate diagnosis of the specific local challenges policy seeks to address needs to be the first step in understanding how the overall evidence applies in any given situation.

However, while detailed local knowledge and context will be important in undertaking that analysis, as in most policy areas we have considered, the evidence presented here doesn’t make the case for local over national delivery (or vice-versa).

The evidence does urge caution on the role that more localised innovation policy could play in driving local economic growth. Local decision makers need to think carefully about their desired objectives. For example, our review shows that tax credits have a pretty good success rate in raising R&D spending (particularly for smaller / younger firms). Equally, R&D grants programmes which include a collaboration element seem effective at raising R&D activity. But in both cases we know much less about whether or how this increased R&D activity feeds through to greater innovation, better firm performance or longer term economic growth, particularly at the local level. These broader outcomes are the things most local economic decision makers ultimately care about.

There are also good reasons to think that many of these broader economic benefits are likely to ‘spill over’ beyond the immediate area in which the policy is implemented. This might still result in a net benefit for the place implementing the policy, but such spillovers reduce the economic benefits to individual areas and strengthen the case for national policy.

Local R&D support programmes could also result in inefficiently high levels of support if footloose firms are able to extract more generous support from competing local areas regardless of any net beneficial impact. Any moves to devolve policy in the UK would need to test for these issues.

Overall, then, it is important to remember that evaluation of the impact of innovation policy is still limited and this review raises as many questions as answers. The limited evidence base, particularly in

terms of the impact on local economic outcomes, highlights the need for realism about the capacity and evidence challenges of delivering innovation policy at a more local level.

## Helping to fill the evidence gaps

Given the importance of R&D support programmes in the innovation policy mix – and in wider policy agendas such as industrial strategy – it is important to think how we might generate further high quality impact evaluation evidence. Study 1208, which evaluates the UK R&D tax credit, is one example of best practice, which combines detailed administrative data (from HMRC) with scheme performance data, and exploits a change in scheme design to evaluate impact.

Government could help evaluate other policies by releasing similar datasets, including cost data, to researchers (to allow construction of treatment and control groups and calculations of cost-effectiveness). Policymakers should also think about how to implement policies in ways that facilitate evaluation – for example, through competitive application processes, or by staggering programme rollout across locations and/or time.

Very few studies look at economic effects of R&D support beyond immediate impacts on R&D spend, to consider patents or reported innovation, or wider firm or area-level outcomes, such as productivity or concentrations of star scientists. If the ultimate aim of R&D support policies (especially at the local level) is to influence innovation and growth, it is crucial that we evaluate future policies against these wider objectives. To do this, policymakers have to ensure that researchers can link firm-level data on tax, financial assets, productivity, jobs and innovative activities.

We need a much better sense of how different forms of R&D support perform against each other (grants / subsidies / loans vs tax credits), and against other aspects of innovation policy (such as those covered in NESTA's Compendium of Evidence on Innovation Policy). Better data on scheme reach and participants will help researchers to do this.

Similarly, we need more evidence on the appropriate policy mix, including whether regional or urban-level policy is appropriate. Innovative activity tends to cluster, and local 'ecosystems' often have unique characteristics. This implies that local policy could have a role to play. But as we discussed above, the benefits of innovation is not always spatially bounded, and traditional local cluster programmes have a very poor success rate.

The review identifies a number of specific evidence gaps:

- A lack of credible strategies to deal with firm selection issues. In particular, only five of the 42 studies are able to deal with selection effects (leading to e.g. strong or weak firms being over-represented in a given programme). In turn, this casts doubt on the true size of programme effects, which may be larger or smaller than those reported here. There is suggestive evidence of positive selection from some of the studies, which implies that the true effects are *lower* than reported. More credible experimental and quasi-experimental evidence is needed, for example using pre-selection plus random assignment, or competitive funding programmes where outcomes for winners and losing bidders can be compared.
- A lack of detail on optimal programme design features.
- A lack of evidence on cost-effectiveness.

The Centre's longer term objectives are to ensure that robust evidence is embedded in the development of policy, that these policies are effectively evaluated and that feedback is used to improve them. To achieve these objectives we want to:

- work with local decision makers to improve evaluation standards so that we can learn more about what policies work, where.
- set up a series of 'demonstration projects' to show how effective evaluation can work in practice.

Interested policymakers please get in touch.



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## Appendix A: Findings by outcome

Table A1: Programme effects by outcome and objective

Outcome	Programme Rationale and Outcome Evaluated	Not Programme Rationale but Outcome Evaluated	Total assessed	Positive	Mixed	Zero	Negative	Share positive
Increase R&D spend	388, 397, 407, 449, 460, 467, 471, 495, 505, 507, 518, 530, 536, 809, 1153, 1205, 1210, 1211		18	397, 449, 460, 471, 495, 530, 1210, 1211	388, 407, 505, 507, 518, 809, 1153, 1205	467	536	8/18
Innovation outcomes								
Patents	397, 402, 407, 421, 449, 467, 500, 524, 526, 1209, 1212, 1318		12	397, 402, 407, 421, 449, 1212	1209	467, 524, 500, 526, 1318		6/12
Product innovation	424, 467, 499, 514, 516, 1318		6	424, 499, 514, 1318	516	467		4/6
Process innovation	424, 467, 499, 516, 1318		5	424, 467, 499, 1318	516			4/5
Other	392, 424, 438, 468, 526		5	526	392, 424, 438, 468			1/5
Economic outcomes								
Productivity	450, 467, 472, 479, 490, 509, 530	524, 1210	9	450, 490, 509, 530	479	467, 472, 524, 1210		4/9
Sales, Turnover or Profit	421, 424, 450, 472, 1318	466, 467, 490, 524, 527, 1153, 1210	12	424, 450, 467, 490, 527, 1210, 1318	466, 1153	421, 472, 524		7/12

Outcome	Programme Rationale and Outcome Evaluated	Not Programme Rationale but Outcome Evaluated	Total assessed	Positive	Mixed	Zero	Negative	Share positive
Employment	421, 490	467, 524, 526, 527, 530, 809, 1210	9	467, 490, 526, 527, 530, 1210	421, 809	524		6/9
Other	472, 490, 492, 517	467, 524, 526, 530, 809, 1153, 1210	11	467, 472, 490, 492, 517, 526	524, 809, 1153	530, 1210		6/11

Table A2: Number of “Works” plus “May help” per outcome category and programme type

Category	R&D spend	Innovation outcomes	Economic outcomes
Private	2/6	1/2	4/9
Collaboration	3/3	4/5	4/6
Research	0/1	2/2	0/0
Miscellaneous	3/8	3/6	1/1

## Appendix B: Evidence Reviewed

Ref no.	Reference
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Ref no.	Reference
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Find the full list of search terms we used to search for evaluations on our website here:

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