



FINAL REPORT

R&D Tax Incentive Programme Review

*Prepared for the
Department of Industry, Innovation and Science
29 March 2016*

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Summary

This report

The Australian Government Department of Industry, Innovation and Science (the department) commissioned the Centre for International Economics (CIE) to provide independent advice to the R&D Tax Incentive (R&D TI) programme review. Following the implementation of the research strategy, this report presents the CIE's findings from its analysis.

The terms of reference for the CIE's review are set out in Appendix A.

The research strategy used for this report

The main items of research completed for this review and presented in this report were:

- stakeholder consultations (including consideration of relevant submissions to recent government consultation processes)
- a review of international and Australian literature (including two other research projects commissioned by the department)
- a customised survey of R&D TI recipients
- subsequent analysis using statistical and economy-wide modelling to understand the broader costs and benefits of the programme.

The evaluation strategy used for this report

The R&D TI is a core government programme designed to increase R&D by providing subsidies through the tax system using a tax offset based on R&D spending. The object of the programme is clearly set out in the legislation:

... to encourage industry to conduct **research and development activities** that might **otherwise not be conducted** because of an uncertain return from the activities, in cases where the knowledge gained is likely to **benefit the wider Australian economy**.

— *Tax Laws Amendment (Research and Development) Act 2011*, emphasis added.

The research evaluation strategy used in this report was driven by the core requirement for the programme to generate economic benefits, in line with this objective.

For the programme to generate those benefits, three broad conditions must be met:

- First, funds provided (through the tax offset) must be spent on genuine R&D, consistent with the requirements of the legislation.

- Second, this genuine R&D spending must be additional to R&D that would have taken place in the absence of the programme. Funding for R&D that would otherwise have taken place will not generate incremental benefits as a consequence of the programme.
- Third, this genuine and additional R&D spending must result in wider economic benefits (often called ‘spillovers’) that accrue to the broader economy and not just to those who undertook the R&D. Without such spillovers, the accepted rationale for the programme is not satisfied.

Key findings

The key findings from the research and evaluation are introduced here and are discussed further in this section.

- 1 There is general in-principle agreement that because of the spillovers (wider economic benefits) associated with business R&D there is a case for government measures to attempt to induce additional R&D (that is, R&D that would not have otherwise taken place) in order to achieve a greater level of spillover.
- 2 While there is some debate about the exact form such measures should take, there is also agreement that the use of the tax system is appropriate as a component of strategies to generate wide benefits from R&D.
- 3 At the same time, there is a general understanding that the practical application of tax policies designed to induce additional R&D is subject to a number of trade-offs and constraints. There is broad agreement on general principles of best practice when using the tax system in this way.
- 4 Further, the general literature acknowledges that it is hard to measure the impact of policies such as the R&D TI. Internationally, a full benefit–cost analysis of similar programmes has taken place in only a few cases.
- 5 The benefits emerging from the programme depend crucially on additionality (the extent to which the programme induces additional R&D) and spillovers (the extent to which the additional R&D generates wider economic benefits). Both are hard to measure empirically.
- 6 International literature suggests that additionality (defined as the dollar increase in R&D per dollar of incentive provided) is around 1. The empirical estimates presented in this report suggest a range from 0.3 to 1.5. Separate empirical research commissioned by the department suggests a value between 0.8 and 1.9.
- 7 Our empirical estimates consistently suggest higher additionality for small firms compared to large firms. This is also consistent with most of the international literature. In our analysis for Australia, this difference remains even as the threshold for small versus large is varied.
- 8 Spillovers are similarly hard to estimate. The analysis presented here follows the work of the Productivity Commission (PC) and focuses on the link between R&D and productivity. Our empirical estimates are consistent with the range suggested by the

PC. As the PC has also noted, it is not possible to provide definitive estimates of spillovers.

- 9 Our empirical research also suggests that the compliance costs of the programme are around \$37,000 per firm per year. This is approximately 9% of the tax benefit received.
- 10 Programme administration costs are estimated at up to \$25 million per year, or approximately 1% of benefits provided to firms.
- 11 More broadly, stakeholder consultations identified no major concerns about programme administration.
- 12 Looking at the benefits of the programme compared to its costs, the annualised value of net benefits of the programme varies from –\$0.4 billion to +\$3.5 billion, and the benefit–cost ratio from 0.6 to 4.4 (assuming an additionality rate of 0.82 and a range of benefit profiles estimated based on survey results). The results are highly sensitive to the additionality rate and spillover effects assumed. The estimated benefits of the R&D TI could be compared with potential alternative uses of the funds—such as other research programmes or general tax cuts—which would require higher additionality and spillover rates than break-even but which are possible within the range of rates identified.
- 13 Our estimates suggest that there is potentially a very high return from efforts to increase additionality (\$77 million to \$566 million for every 0.1 increase in the additionality rate).
- 14 There is a limited amount that the programme can do in its current form to increase additionality. First, while additionality is a key objective of the legislation, the legislation contains no particular methods for enforcing additionality. Second, the additionality rate for an individual firm is determined by a range of factors outside the control of the programme.
- 15 The main option for increasing additionality is to target the composition of the scheme towards firms with higher additionality. In practice, given the current knowledge base, this implies maximising coverage for small firms.
- 16 In the area of programme administration, there is some suggestive, but far from definitive, evidence that changing the timing of registration in relation to the conduct of the research may lead to higher additionality.

Rationale

It is widely agreed that because of the nature of knowledge spillovers, and the potential for underinvestment in R&D, it is appropriate for the government to use instruments to encourage additional R&D that will subsequently result in additional spillovers.

It is also generally agreed that R&D spending responds to changes in the cost of undertaking R&D; lowering R&D costs will, all other things being equal, lead to additional R&D.

Further, it is widely agreed that tax incentives in the form of tax offsets for expenditure on R&D have the effect of lowering R&D costs, which should induce additional R&D.

What is uncertain is the exact extent to which a dollar of tax incentive (that is, a dollar of tax forgone or cash refund, from the government's perspective) will lead to incremental R&D by firms when compared with business as usual. Will a dollar of incentive result in a dollar of incremental R&D, or more or less than that amount?

In addition, the incentive by itself cannot guarantee the value of spillovers associated with the incremental R&D. Can the use of the taxation system to transfer resources from taxpayers to firms conducting R&D generate net social benefits compared with alternative uses of those tax resources?

These specific empirical questions need to be addressed to consider whether the incentive can achieve its objectives cost-effectively.

Underlying trade-offs

The use of the tax system to encourage additional R&D involves a number of trade-offs:

- On the one hand, a tax-based instrument takes advantage of the taxation infrastructure already in place by using monitoring and compliance systems that are broadly familiar to most firms.
- Similarly, using the tax system allows for effective R&D subsidies that are neutral with respect to the nature of the firm involved, the nature of the R&D involved, and the size of the firm (aside from the non-neutral elements deliberately introduced into the R&D TI).
- On the other hand, the tax system is a very blunt instrument with which to achieve either additionality or spillovers from research. 'Blunt' in this sense means that the system has limited ability to control or target additionality or spillovers. Indeed, the rates of additionality and spillover are largely determined by factors outside the R&D TI.
- Further, during consultations we observed that the use of the tax system results in a strong tendency to view the R&D TI as a 'tax measure' rather than as an 'R&D measure'.
- As configured in Australia, the R&D TI applies to all R&D, whether or not it is truly additional. It is a 'volume'-based scheme rather than an 'incremental' scheme. This means that the incentive by itself is unable to target additional R&D. However, international experience suggests that attempts to focus only on 'incremental' R&D introduce undesirable distortions into R&D decisions.
- Similarly, the R&D TI does not contain any particular instruments to ensure maximum spillovers, aside from an initial threshold to ensure that R&D expenditure claimed is for genuine R&D.

Empirical uncertainties

The two most crucial elements of the R&D TI (additionality and spillovers) turn out to be extremely difficult to empirically measure and evaluate.

Additionality cannot be directly measured and must be inferred through interviews, surveys, statistical analysis and modelling. Therefore, estimates of additionality will always be imprecise and subject to uncertainty. In the analysis presented here, we have tried to be very explicit about this uncertainty, using statistical and modelling techniques to provide a range of estimates.

Spillovers, while in principle evident from the techniques of growth accounting, have also proved to be extremely difficult to measure empirically. At one extreme, it is understood that spillovers are likely to be quite large: Baumol (2010) estimates that the spillover rate in the US may be as high as 90%. Precise estimates using focused Australian data have proved more elusive.

Despite the theoretical credentials of this policy and the popularity of tax incentives around the world, the effects of the policy will remain difficult to determine while these empirical uncertainties remain.

Additionality

This report reviews a range of evidence on additionality, including the literature, survey results and the latest results of econometric analysis. For convenience, we define additionality as the dollar increase in R&D spending for each dollar of tax incentive provided.

- Most international studies suggest a value around or slightly less than 1. In the international literature, there is general scepticism about numbers significantly greater than 1.
- Detailed analysis of our survey results, using both 'stated' outcomes (what the firms told us when we asked directly) and modelled outcomes (using the survey results to calibrate an economic model of R&D) suggests overall additionality of between 0.3 and 1.5; the higher rate is for small to medium enterprises (SMEs) only.
- Our estimates (based on detailed survey results) suggest that additionality is statistically significantly higher for SMEs than for large firms.
- Separate econometric work commissioned by the department compares R&D undertaken by firms receiving the R&D TI with R&D undertaken by a control group that does not receive the R&D TI. That work suggests an additionality rate in the 0.8–1.9 range.
- Discussions during our consultations, and in interviews with individual firms, were consistent with these overall results.

Additionality and SMEs

A similar range of evidence consistently suggests much higher additionality rates for small firms versus large firms:

- Results from our survey, under all alternative approaches, suggest that SME additionality is between two and three times higher than that for large firms.

- There is also compelling evidence from consultations and interviews that small start-ups, particularly in the research-focused biological and medical areas that receive a cash refund from the offset, rely on it to be able to continue their research. In their case, additionality is relatively high.

Spillovers

Evidence on spillovers is considerably harder to gather. There is limited information in the international literature, and some of the best work in this area remains that done by the Productivity Commission and reported in its *Public support for science and innovation* report (PC 2007).

- A recent Australian study (Elnasri and Fox 2014) looked at using intangible capital within a growth accounting framework. It found no evidence of spillovers from induced business R&D, along with very strong evidence of spillovers from other forms of R&D.
- In our survey results, we note that on average 56% of R&D spending is targeted at new products or processes. This breaks down into 67% for small firms and 55% for large firms. To the extent that there are more spillovers associated with new products, these results suggest higher (marginal) spillovers from small firms.
- Considering other outcomes from R&D, the survey results suggest that 32% of R&D results in products or processes new to Australia (31% for large firms and 59% for small firms). Again, this suggests higher (marginal) spillovers from small firms (to the extent that novelty is associated with higher spillovers).
- Further, the survey suggests that 24% of R&D results in products or processes new to the world (24% for large firms and 46% for small firms). This is consistent with other survey results.

Benefit–cost analysis

Based on our central estimate of the additionality rate (0.82) and a range of benefit profiles estimated based on survey results, the annualised present value of net benefits (benefits minus costs) of the programme varies between –\$0.4 billion and +\$3.5 billion, and the benefit–cost ratio (BCR) from 0.6:1 to 4.4:1. The BCR for small firms is greater (0.7:1 to 5.2:1).

However, the results are highly sensitive to the additionality rate and assumed spillover effects:

- Based on the range of parameter values for additionality and spillovers identified in this evaluation, the programme is likely to realise a BCR greater than 1.
- The estimated benefits of the R&D TI could be compared with potential alternative uses of the tax revenue, such as other research programmes or tax cuts, involving revenue costs equivalent to those of the R&D TI.
- The required BCR to be equivalent to tax cuts would be in the 3:1–5:1 range, which is achievable, but probably difficult for the R&D TI.

- BCRs achieved through other research programmes have been estimated to be around 7:1. For the R&D TI to lead to a BCR comparable to those alternatives, the additionality rate and spillover effects would need to be at the highest end of the ranges estimated in the empirical literature.

These benefit–cost findings are broadly consistent with the limited estimates available in the international literature.

Collaboration

The only feature of the R&D TI that is likely to directly encourage collaboration between firms and researchers is the Research Service Provider (RSP) programme. A comparison of results from our survey with those from a survey of RSPs commissioned by the department shows differences in perceptions between researchers and business:

- While both researchers and firms agreed that there are potential gains from further collaboration, firms considered that the major constraints to further collaboration were differences in expectations, culture and timing.
- In contrast, researchers considered that the major constraint was the lack of technical knowledge on the part of firms.

Response to the terms of reference

Table 1 draws together the material presented in this report to provide responses to each of the points in the terms of reference for this review.

Table 1 Summary of findings against the terms of reference

Terms of reference	Findings	Page reference for relevant section of report
1. Need		
a. How is the R&D Tax Incentive programme, its policy rationale (including addressing market failures) and objectives, contributing to meeting the government's broader economic objectives as articulated in the Industry Innovation and Competitiveness Agenda?	The incentive is consistent with the Industry Innovation and Competitiveness Agenda ambition of fostering innovation and entrepreneurship.	24
	That said, the programme does not directly deliver on any of the specific topics in the agenda.	
	Further, the programme indirectly contributes to innovation through the presumption that funding R&D inputs will lead to innovative outputs and impacts.	
	The theoretical justification and policy rationale are consistent with the government's economic objectives.	20
	There is evidence that the programme is increasing R&D in Australia.	103
b. Is the R&D Tax Incentive the right vehicle to drive business innovation?	The R&D TI is an effective vehicle to drive business innovation, as demonstrated by a positive additionality rate.	137

Terms of reference	Findings	Page reference for relevant section of report
	The available evidence suggests that the additionality rate of the programme is between 0.3 and 1.5. An alternative policy with a higher additionality rate is likely to be more effective at increasing R&D.	103
	Improvements to the R&D TI may also increase the additionality of the programme.	128
	Any assessment of alternative or improved policies should consider the trade-offs between the cost of delivery and additionality.	
	Alternative approaches would include grants, procurement or R&D contracts, and industry consortia. Australia already has some complementary policies, and others have been introduced in the government's recent National Innovation and Science Agenda.	46
2. Design and theory		
a. To what extent does the design and features of the R&D Tax Incentive, including changes introduced through recently passed legislation, appropriately address the policy objectives of the programme?	The design features of the programme are appropriate for using a tax incentive to achieve the aims. However, there are pros and cons to using a tax incentive.	25, 74
	A higher offset rate would be expected to increase R&D investment marginally.	29
	The rate reduction measure, while unlikely to significantly affect R&D investment in itself, is yet another change to the programme (and a retrospective one) that contributes to uncertainty, which has significant impacts on the perception and use of the programme.	62, 169
	There do not appear to be significant barriers to SME participation in the programme. The 45% refundable offset makes the programme very attractive to SMEs, particularly those in loss.	62, 88, 162
	As a volume-based measure (as opposed to an incremental measure) the policy supports all R&D, not just additional R&D. The definitions used under the programme aim to ensure that claims are for genuine R&D. While some feedback suggested that the definitions are not appropriate for businesses, we have concluded that they are appropriate and ensure that claims are for legitimate R&D.	23, 62, 173
	The programme and underlying legislation have no specific mechanism to eliminate business-as-usual claims. Requirements for additionality and spillovers are not expressly included in the legislation.	23
	By allowing selected overseas activities, the R&D TI helps support global R&D investment. This provision may have a material impact on a small number of firms. Australia may benefit from having these firms locate in Australia, but the extent of that benefit is difficult to determine and is likely to be very small.	62
	The benefits of any change to the programme need to be weighed against the cost of implementing the change. Any changes to the programme reduce its effectiveness by	62, 169

Terms of reference	Findings	Page reference for relevant section of report
	increasing uncertainty.	
	The threshold measure (\$100 million cap) may lead to large firms not considering the R&D TI in their decision-making, as the incentive will not affect their marginal decisions beyond \$100 million investments. The budget savings achieved through this measure need to be balanced against the lost benefits of spillovers associated with the reduced investment by these firms.	62, 171
b. How does the R&D Tax Incentive programme compare with international practice?	The design of the R&D TI compares favourably with international practice. Based on benchmarking of the theoretical and administrative characteristics of the programme, the R&D TI ranks among the top 10 R&D tax schemes.	41
	Some favourable attributes of other schemes could be implemented in Australia to reduce the cost of the programme and increase additionality, such as improvements to guidance material or shifting the timing of the registration process.	128, 138
	OECD comparisons of support to businesses for R&D rank the generosity of Australia's scheme as being around average for large firms and above average for small firms.	33
c. Does the R&D Tax Incentive have a role to play in facilitating greater researcher–industry collaboration?	The only element of the R&D TI programme that specifically targets collaboration is the RSP provisions. However, the RSP element does not appear to have a significant impact on collaboration.	75
	Options to increase collaboration within the R&D TI programme could include greater offset rates for collaborative projects. This may lead to some increase in collaboration; however, much of the feedback received indicated that there are non-financial barriers to collaboration that may need to be addressed first.	75, 172
3. Process and implementation		
a. Since its introduction, has the R&D Tax Incentive programme been effectively implemented and administered?	Overall, the implementation of the R&D TI appears to have been effective. However, continual changes to the policy and retrospective changes affect the perception and use of the programme. A minority of activity reviews are seen to be onerous and lengthy. There appear to be some concerns about consistency in the application of definitions among some AusIndustry staff.	62, 72, 166
b. Is the R&D Tax Incentive programme well understood by stakeholders and easy to access?	Most stakeholders appear to understand the programme. There were suggestions that the guidance material from AusIndustry could be improved; in particular, publishing decisions on the eligibility of activities would help to increase transparency.	62
	Some changes to the application process and application guidance could improve ease of access to the programme and reduce firms' reliance on consultants without compromising the programme's integrity.	138, 166
4. Outcomes and impacts		

Terms of reference	Findings	Page reference for relevant section of report
a. To what extent does the evidence indicate that the R&D Tax Incentive is meeting its policy objectives, including encouraging additionality, as well as enabling the improved realisation of returns and improved decision making by firms, and identify areas for further improvement?	It is estimated that the R&D TI has an additionality rate of between 0.3 and 1.5. That is, for every \$1.00 of forgone tax revenue, there is an increase in R&D expenditure of between 30 cents and \$1.50. Around 60% of the increase in R&D expenditure is for labour costs.	103
	There is very little evidence, if any, that the R&D TI has increased collaboration between industry and researchers.	75, 93
	There is limited evidence of significant spillovers from business R&D. Work by the PC in 2007 showed that, for each 1% increase in market-driven R&D, productivity increased by 0.02%. The PC also produced a range of estimates, and the findings in this report are consistent with that range.	58
	Consultants have suggested that firms that use consultants to help with the R&D TI process also benefit from improved record-keeping and decision-making processes. Improved R&D behaviour could be further enhanced by separating the R&D TI from tax processes, for example by requiring registration before R&D projects are completed.	62, 128
b. How does the R&D Tax Incentive contribute to Australia's international competitiveness, at both the firm level and for the innovation system as a whole, and can it be improved upon?	By lowering costs to firms, the R&D TI increases the competitiveness of firms relative to a situation without the R&D TI. However, other measures (such as reducing the corporate tax rate) could be more effective at increasing international competitiveness.	27
	Some stakeholders claimed that the R&D TI determined the location of investment, while others claimed that the R&D TI is not generous enough to drive those decisions.	62, 161
	The location of R&D activities and related business activities depend on many different factors, one of which is the R&D TI. The importance of the R&D TI varies among industries and firms.	162
c. How can the impacts of the R&D Tax Incentive programme best be evaluated in the future?	It is very difficult to assess the programme with currently available information. Future programme reviews will benefit from an improved evidence base of time-series data on how the incentive has affected firms' R&D decisions. This could be gathered through some additional targeted questions in the registration process, in combination with further questions in the Australian Bureau of Statistics' survey of business R&D.	138
5. Cost and efficiency		
a. Can the cost of the R&D Tax Incentive programme be better understood and estimated?	The programme does not currently contain systematic measures to allow for ongoing economic evaluation. Building an evaluation information base will be useful for future evaluations of the programme and for monitoring change in the programme over time. This is also likely to help in delivering value for money to the taxpayer.	139
	The greatest cost of the R&D TI (from the perspective of government) is the forgone tax revenue and refunded tax offsets. While this is subject to some uncertainty, this dollar cost is directly related to the amount of subsidy provided to recipient firms; a lower dollar cost would imply a lower	119, 126

Terms of reference	Findings	Page reference for relevant section of report
	subsidy, and therefore lower benefits. As the programme is volume based and not limited (apart from the \$100 million expenditure cap), future programme costs will be driven by business investment decisions and are therefore difficult to forecast, but are likely to be correlated with changes in business activity levels.	
b. In light of the government's Deregulation Agenda, how could the R&D Tax Incentive programme be made more efficient and less burdensome on participants?	As noted in the response to the third term of reference, some improvements could be made to the application process and to activity reviews to reduce the burden on businesses. One suggestion is to allow for registration across multiple years for long-running projects.	138,166

Source: The CIE.

Recommendations

Based on the results of the research conducted for this review, we have made recommendations on possible improvements to the programme.

Lowering compliance costs

Any actions to lower compliance costs (provided there are no implications for the integrity of the programme) will result in an improvement of the programme.

While it is difficult to provide a benchmark, compliance costs for the programme are relatively high as a proportion of the potential benefits of the programme. Lowering compliance costs has the potential to increase net benefits from the scheme.

One method for reducing the compliance cost for firms would be to continue to improve the accessibility and nature of guidance material about the programme while increasing the ease of interacting with the programme regulators.

One strategy for this is to continue to use modern web-based methods to convey information to participants, particularly information about the specific definitions relating to eligible R&D expenditure. Web-based products already in the market, while not directly suitable for use by AusIndustry, indicate the possibilities for effective and contextual information dissemination.

Another proposal to reduce compliance costs that arose from stakeholder consultations is to allow for the registration of a single project extending over multiple years in a single application process. This would avoid duplication of effort across more than one year.

Increasing additionality

Because additionality is a central driver of the benefits of the programme, efforts to increase it would be worthwhile. Our analysis concludes that a 0.1 increase in the average additionality rate could yield benefits of between \$77 million and \$566 million per year.

As noted, however, the additionality rate for an individual firm is determined by a range of factors outside the control of the programme. Therefore, efforts could be focused on increasing the average rate under the programme by changing the composition of firms in the programme.

Average additionality could be maximised by increasing the proportion of participants with high individual firm additionality. We therefore recommend that the programme maintain its relative focus on small firms (which empirically have higher additionality rates).

Further, there is some suggestive, but far from definitive, evidence that changing the timing of registration relative to the conduct of the R&D may lead to higher additionality. In particular, requiring registration before or during an R&D project (rather than after it has taken place) seems to have led to higher additionality in some international schemes.

Enhancing the information base

As noted throughout this review, there are significant difficulties in measuring additionality and spillovers arising from the R&D TI. This means that a sound quantitative estimate of the overall benefits of the scheme to the economy (or an estimate of the value that the taxpayer receives for their expenditure) will always be subject to considerable uncertainty.

While the nature of these factors means that they are likely to remain uncertain to some extent, improvements can be made to the information base held by the government to allow for better understanding of the impacts of the programme.

We note that the programme does not currently contain systematic measures to allow for ongoing economic evaluation. While it will not deliver benefits immediately, the steady building up of an evaluation information base is likely to help in delivering value for money to the taxpayer.

This will be particularly useful for future evaluations of the programme and for monitoring change in the programme over time.

Key recommendations in this area include:

- 1 Undertake wider and more systematic analysis of information contained in tax returns, which was not possible for this review. Tax information is of course sensitive and is quite correctly held securely and in confidence by the relevant authorities. However, given the potential benefits in understanding the impacts of the programme, we consider it worthwhile to systematically explore ways of appropriately using this information.

- 2 Work with the Australian Bureau of Statistics to enhance the current business R&D survey. The existing survey is not directly suitable for evaluation purposes but it could become so with the addition of evaluation-type questions. Our experience in conducting a special-purpose survey suggests that these surveys will become more difficult in the future (particularly in achieving a high response rate). Working with the bureau will both reduce the burden on firms and increase the likelihood of an adequate response.
- 3 Include broader evaluation questions as part of the registration process. There is clearly a trade-off here with the need to minimise compliance costs, but it is worth exploring the possibility of incorporating evaluation questions into the registration database.
- 4 Consider the possibility of controlled experiments, as recommended by Thompson and Skali (2016), to improve knowledge of the responsiveness of firms to incentives to increase R&D. Appropriately constructed controlled experiments have the potential to reveal information not currently available to policymakers about the effectiveness and optimal settings of R&D policy, including the R&D TI.

1 Introduction

The Research and Development Tax Incentive (R&D TI) is the Australian Government's principal measure to encourage industry investment in research and development (R&D). The R&D TI provides businesses with a tax offset on eligible R&D expenditure and thereby offsets some of the costs of doing R&D.

In 2013–14, there were more than 11,000 R&D TI registrants, and the cost to government in forgone tax revenue and refunded tax was around \$2,951 million (Department of Industry and Science 2015).

In general, it is a major policy aim that government resources are invested to maximise national economic benefits. This study looks at the appropriateness, effectiveness and efficiency of the R&D TI and explores wider implications of supporting innovation through the tax system.

Overview of the R&D Tax Incentive

The R&D TI was introduced in 2011 to replace the former R&D Tax Concession. The R&D TI is a broad-based measure that is open to all industry sectors. By offsetting some of the costs of doing R&D, the programme encourages industry to conduct R&D that might not otherwise have been conducted. The current settings for the programme have two core components:

- a 45% refundable tax offset¹ for eligible entities with turnover of less than \$20 million per year, provided they are not controlled by income tax exempt entities
- a non-refundable 40% tax offset² for all other eligible entities (unused non-refundable offset amounts may be carried forward to future income years).

Companies are required to have R&D expenditure of at least \$20,000 to be eligible for the R&D TI.³ With effect from 1 July 2014, a \$100 million threshold applies to the R&D expenditure for which companies can claim a concessional tax offset. For any R&D expenditure amounts above \$100 million, companies are still able to claim a tax offset at the company tax rate.

1 This is effectively equivalent to a 150% tax deduction if the firm has a sufficiently high taxable income. Loss-making firms will receive a cash refund of 45 cents per dollar of eligible R&D expenditure.

2 Given a sufficiently high taxable income, this is equivalent to a 133% tax deduction.

3 This requirement is relaxed for firms using Research Service Providers.

The programme is open to companies that are incorporated in Australia; corporations that are Australian residents for tax purposes; foreign corporations that carry on R&D activities through a permanent establishment in Australia; and corporations acting as trustees of public trading trusts. Non-incorporated entities (such as sole traders, partnerships and most trusts) are not eligible; nor are corporate limited partnerships or companies whose entire income is exempt from income tax.

R&D activities are defined, for the purposes of the programme, as experimental activities:⁴

- whose outcome cannot be known or determined in advance on the basis of current knowledge, information or experience, but can only be determined by applying a systematic progression of work that:
 - is based on principles of established science, and
 - proceeds from hypothesis to experiment, observation and evaluation and leads to logical conclusions, and
- that are conducted for the purpose of generating new knowledge (including new knowledge in the form of improved materials, products, devices, processes or services).

The programme specifically excludes a range of activities, including market research; prospecting, exploring or drilling for minerals or petroleum for discovering or determining the size, quality or location of deposits; and research in social sciences, arts or humanities.⁵

There are provisions in the programme to ‘claw back’ tax offsets associated with expenditure funded through government grants or for activities that produce tangible products (through feedstock adjustments). These provisions prevent companies receiving enhanced benefits on monies received from government (so-called ‘double dipping’) or for expenditure that results in a saleable good.

Companies wishing to claim the R&D TI must register their activities with AusIndustry before they are able to claim the tax offset in their annual income tax return by completing the Australian Tax Office’s (ATO’s) R&D Tax Incentive Schedule. Registrations must be completed within 10 months of the end of the income year in which the R&D was conducted.

The R&D TI is a self-assessment programme, so most applications are registered without formal examination of the eligibility of activities. The integrity of the programme is assured through monitoring and assessment under AusIndustry’s compliance model in addition to the ATO compliance programme via risk reviews and audits. This approach is used to minimise the compliance burden for government and participants while maintaining the integrity of the programme.

⁴ Subsection 355-25(1), *Income Tax Assessment Act 1997*.

⁵ Other excluded activities are listed in subsection 355-25(2) of the *Income Tax Assessment Act*.

This report

Purpose and aim

The Centre for International Economics (the CIE) was engaged by the Department of Industry, Innovation and Science to assist with the review of the R&D TI programme. The terms of reference for the review are included in Appendix A.

This report provides a general programme review that seeks to evaluate the appropriateness, effectiveness and efficiency of the programme based on the Department of Finance's Expenditure Review Principles.

It was also produced to contribute to the wider Australian Government review of the tax system (the Tax White Paper process). In the White Paper discussion paper, *Re:think—Better tax system, better Australia* (Commonwealth of Australia 2015a), the government announced that it would review the provision of support for innovation through Australia's taxation system and the operation of the R&D TI.

The Senate Economics Legislation Committee, in its report on the introduction of the legislation for the R&D TI in 2010,⁶ recommended that the amended provisions of the Act be reviewed after two years of the programme's operation to ensure that the legislation is operating consistently with the government's intent (Senate Economics Legislation Committee 2010). A policy review was also noted in the *Boosting commercial returns from research* report (Department of Education and Department of Industry 2014).

The Department of Finance's Expenditure Review Principles require economic evaluations to consider a programme's appropriateness, effectiveness, efficiency, integration, performance assessment and strategic policy alignment. Further details of the principles are in Appendix A. In particular, this report considers:

- the appropriateness of the R&D TI, by considering the rationale for government intervention and the objectives of the policy
- the effectiveness of the programme, by determining whether it is achieving its objectives, such as inducing new R&D expenditure and producing economy-wide spillover benefits
- the efficiency of the programme, by using a comprehensive benefit–cost framework that takes account of all costs of the programme, including compliance, administrative and efficiency costs.

The Tax White Paper discussion paper posed the questions:

Does the R&D tax incentive encourage companies to conduct R&D activities that would otherwise not be conducted in the absence of government support? Would alternative approaches better achieve this objective and, if so, how?

⁶ Tax Laws Amendment (Research and Development) Bill 2010 [Provisions] and Income Tax Rates Amendment (Research and Development) Bill 2010 [Provisions].

These questions are addressed in this report, and submissions made to the discussion paper are included in relevant material assessed through this study.

Governance and oversight

The terms of reference for this review are provided in Appendix A. Oversight for the review was provided by the Review Reference Group, comprising representatives from major policy and programme areas of the department. Comments on draft reports were sought from across those department areas. This included detailed comments provided by the Economic and Analytical Services Division.

Structure of the report

This report has been structured consistent with the approach used for the evaluation. The responses to the terms of reference for the review are summarised in Table 1 of the Summary.

- Chapter 2 discusses the policy rationale for the R&D TI and the objectives of the policy and introduces the approach and key concepts used for the review.
- Chapter 3 reviews the Australian and international literature on R&D policies, additionality and spillovers. Additional material on international policies is in Appendix B.
- Chapter 4 provides a summary of the consultation process undertaken as part of this review. As part of the review, submissions to the Tax White Paper discussion paper were reviewed; the relevant comments are summarised in Appendix C. Further details of the consultations for the review are in Appendix D.
- Chapter 5 describes the implementation and administration of the programme.
- Chapter 6 discusses some of the design features of the programme, including the use of the tax system to deliver support to innovation and the role of the R&D TI in encouraging collaboration between researchers and industry.
- Chapter 7 introduces the R&D TI survey that was developed and run as part of this review. The chapter also summarises the results of the survey. Further details of the method used to develop the survey are in Appendix E; the survey questionnaire is included in Appendix F.
- Chapter 8 describes the methods used to analyse additionality rates under the programme and sets out the results of that analysis. These estimates are based on the results of the survey and use the CIE's R&D model. Details of the R&D model are in Appendix G. This chapter also includes a discussion of the relationship between additionality and R&D expenditure and turnover. Details of this analysis are in Appendix H.
- Chapter 9 discusses the benefits of the R&D TI. This analysis used the results of the literature review and the survey to provide insight into the expected level of spillovers generated by the programme. The spillovers are combined with the estimated additionality rate and some assumptions about the profile of the benefits over time. A computable general equilibrium (CGE) model is used to estimate the

economy-wide benefits of the programme. Details of the CGE model used are in Appendix I.

- Chapter 10 summarises the costs of the programme, including the administrative and compliance costs, the forgone tax revenue and the deadweight loss of taxation.
- Chapter 11 brings together the estimates of costs and benefits of the R&D TI in a benefit–cost analysis. The results of the analysis are highly sensitive to assumptions of key parameters, which are discussed at length in this chapter.
- Finally, Chapter 12 summarises the findings of the review against the terms of reference and the Expenditure Review Principles.

2 Policy rationale and approach to evaluation

The key rationale for government support of business R&D is that R&D leads to spillovers, which means that the social benefits are greater than the private benefits. This results in less than optimal levels of R&D without intervention. The role of government policy, therefore, is to increase the level of R&D towards the socially optimal level.

The objective of the R&D TI is to encourage R&D that might not otherwise be conducted and that is likely to benefit the wider Australian economy.

This review focused on evaluating the R&D TI in the context of this objective. The two major parameters that determine the effectiveness and efficiency of the programme are additionality (that is, the extra R&D induced by the policy) and spillovers (the extent to which the research leads to benefits beyond the firm conducting the research). However, the legislation does not specifically allow for these factors to be controlled.

Government rationale

In a market-based society such as Australia, the government has a role to play in increasing wellbeing and ensuring equity by supplementing (not replacing) markets. Government programmes and interventions should increase living standards while ensuring that hard work, risk and innovation are appropriately rewarded (NCOA 2014).

Government programmes need to be developed and reviewed in keeping with the appropriate role of governments. Maintaining a focus on that role is important to ensure that policies and programmes remain relevant, appropriate and efficient. Without this focus, there is potential for mission or scope creep, and the resulting programmes may not be optimal.

The National Commission of Audit sets out the things that Australians expect their governments to provide (NCOA 2014). These more or less correspond to correcting examples of market failure—either through the provision of public goods or remedying (positive or negative) externalities. For example, public goods include the provision of law and order, the defence of the nation, and infrastructure such as roads and railways. Positive externalities are created by essential services such as health and education, and negative externalities are controlled by environmental regulations.

The Productivity Commission (PC) has discussed justifications for government support of science and innovation (PC 2007). The various rationales are listed here, however, the PC supported only two of the proposed rationales as being strong justifications for

government support. Both are consistent with the role of government outlined by the National Commission of Audit. The PC noted three proposed rationales as having some validity, and another three as having little merit. This chapter discusses the merits (or otherwise) of the various justifications.

- Strong justifications:
 - Existence of ‘spillovers’ from innovation (the public good nature of research)
 - Publicly funded R&D is a significant contributor to innovation in the functions performed by government
- Justifications with some validity:
 - Intangible value that science elicits and entails
 - Asymmetric tax treatment of profits and losses
 - Imperfections in capital markets that affect finance for risky or uncertain investments by small firms
- Justifications with little merit
 - Addressing the possibility that large research projects cannot easily be divided
 - Business myopia
 - Transforming Australia’s industry

Widely accepted, strong justifications

Public good nature of research

The rationale for government involvement in markets centres on the presence of market failures. Where, for some reason, markets fail to lead to efficient outcomes, there may be a role for governments to intervene to achieve a more efficient outcome for society.

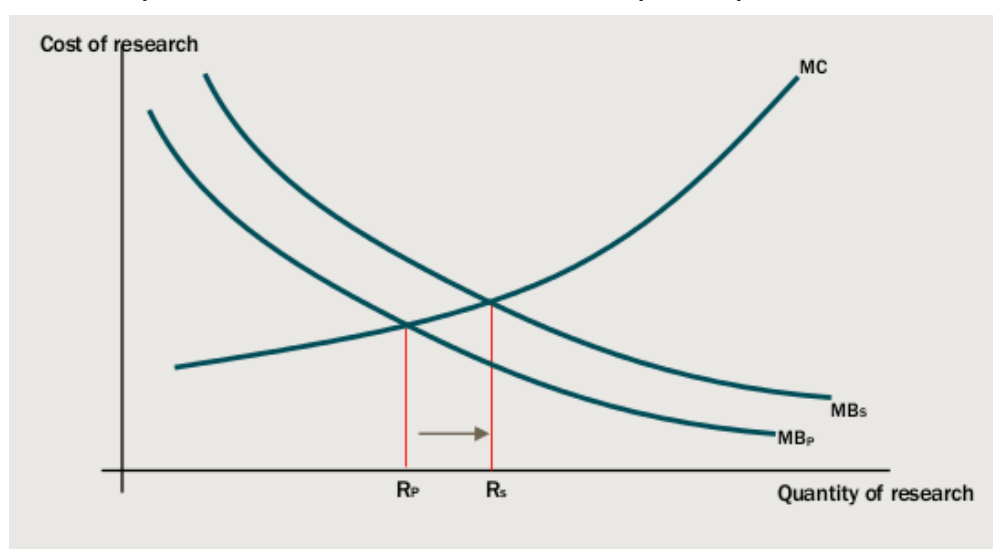
In the case of investment in R&D, it is widely recognised that government intervention is warranted due to the public good qualities of knowledge—that is, knowledge is (to a large extent) non-rival and non-excludable. The use of a piece of information by one party does not necessarily reduce the benefits of that information to others (non-rival), and, despite efforts to protect intellectual property, it is difficult to exclude parties from making use of knowledge (particularly basic or general knowledge) generated by others (non-excludable).

The non-excludable nature of knowledge is the focus of most justifications for government involvement in R&D efforts. Spillover of benefits of knowledge from the original party to others means that the social benefits of a piece of information or knowledge will be greater than the private benefits that can be realised by the party investing in the research. Therefore, the level of investment in R&D by the private sector is expected to be lower than is socially optimal—providing a rationale for government involvement to increase R&D towards the socially optimal level. This is illustrated in Chart 2.1. Given the marginal cost of research (shown by the line MC), a private firm would choose to invest in research at the level R_p , where the marginal costs and benefits to the firm equate (the line MC meets the line MB_p). However, the benefits to society are greater (as shown by the line MB_s), so the socially optimal level of research would be R_s .

Government interventions should aim to increase the level of R&D towards the socially optimal level. However, governments should pursue this only where it is efficient to do so—that is, where the benefits of the intervention are greater than the costs.

A simple example in which providing support to encourage R&D is justified is in the case of new knowledge in a competitive market. A firm may need to make a significant investment to generate new knowledge, yet other firms are able to easily access and absorb the knowledge. Competitor firms adopting the knowledge reduce the benefit to the first firm. In this case, the spillovers to other firms from the initial investment may be significant, and the investment is unlikely to be made without additional incentives because the benefits to the investing firm are short-lived. This warrants government support.

Chart 2.1 Optimal investment in research and development—private and social



Data source: The CIE.

Effective delivery of government functions

Government support for R&D is also strongly justified where the knowledge gained is applicable to the delivery of government goods, services and functions. The absence of public support would lead to the under-provision of the relevant knowledge and therefore to the inefficient supply of those government goods, services and functions. PC (2007) provided further explanation of this justification. The delivery of government functions is likely to be less of a justification for indirect support to business R&D (such as the R&D TI) than for direct, targeted support to ensure that the required R&D is being conducted. More relevant policies to support this rationale would be targeted grant programmes or research procurement programmes. Those approaches are often used in defence policy areas, for example, where firms are encouraged to develop products that can be used by national defence forces. This is a case where the specific objectives of the policy have strong relevance to the choice of the policy instrument.

Other justifications

The PC has presented the arguments for why other justifications are not valid, and most of those are not repeated here. However, two of the commonly asserted reasons are discussed in this section.

Capital market failures

There is evidence that risky projects, of which R&D projects are a specific example, receive lower financing than might be optimal, mostly due to asymmetric information problems. Examples are differences in information about the quality or likely returns of a project between financiers and researchers, and principal-agent problems within the firm leading to difficulties in signalling the value of intangible assets to the market.

Gaps in the capital finance market may not be instances of market failure if transaction costs are accepted as a feature of markets. Governments could intervene to improve finance outcomes and welfare (for example, through interest rate subsidies), but those interventions may impede the development of innovative private initiatives to overcome barriers. Government interventions are also subject to political considerations, which can limit their effectiveness.

Creating jobs and transforming industry

The PC has found that increasing the competitiveness of industry, creating jobs or transforming industry are weak rationales for government R&D programmes. The achievement of those aims is primarily governed by market forces, and there is no role for government intervention.

- Firms should aspire to competitiveness, but exchange rates act to equilibrate international competitiveness. If Australian firms are highly productive, the exchange rate will increase to dampen the effect internationally.
- There is no evidence to show a long-run relationship between technological change and job creation. There is no long-run trend in unemployment rates despite ongoing technological change (PC 2007). New industries or firms that appear to increase employment often displace jobs in other industries.
- Resources (such as labour and capital) are mobile, and the market acts to shift them to industries that realise higher returns as external and internal pressures act on different areas of the economy. Policy responses to structural pressures should be focused on enabling the operation of a flexible economy, of which a broad-based innovation system may be a part.

Further discussion of the rationales for government support of science and innovation is in Chapter 3 of PC (2007).

Policy objectives of the R&D Tax Incentive

The object of the R&D TI programme, according to the legislation⁷, is to:

... encourage industry to conduct research and development activities that might otherwise not be conducted because of an uncertain return from the activities, in cases where the knowledge gained is likely to benefit the wider Australian economy.

This object is to be achieved by providing a tax incentive for industry to conduct, in a scientific way, experimental activities for the purpose of generating new knowledge or information in either a general or applied form (including new knowledge in the form of new or improved materials, products, devices, processes or services).

Based on the wording of the legislation, the rationale for this policy is to address the less than optimal level of R&D investment stemming from the public good characteristics of R&D, resulting in benefits to the wider economy (spillovers).

Despite these elements being included in the objective, the legislation does not fully capture this intent. It does not allow for these factors to be controlled. There is no requirement for applicants to establish that their R&D would not otherwise be conducted; nor is there any need to demonstrate that the R&D would generate spillovers. There are likely to be practical reasons for the legislation not including provisions for this. However, because there is no need for the supported R&D to meet these conditions, they are key parameters that need to be estimated (through this review) to determine the efficiency and effectiveness of the policy.

For government support for research to be justified on the basis of spillovers, the support must lead to an increase in R&D and the benefit of the R&D must accrue to Australians. Therefore, to be effective, government policy needs to provide for additionality—private R&D that would not otherwise take place. To be considered efficient, the total value of the benefits generated from the additional R&D needs to be greater than the costs associated with the policy measure. This review of the R&D TI is centred on the elements of effectiveness and efficiency.

Other suggested objectives

Through the review process, a number of alternatives were raised as justifications for the policy. For example, the policy was said to be necessary or beneficial because it:

- creates jobs
- increases exports
- attracts firms to Australia.

There are two issues here. First, these objectives are not stated in the legislation for the R&D TI. Whether they should be objectives of the programme is a political matter. This review is primarily focused on assessing the R&D TI based on its appropriateness, effectiveness and efficiency in meeting the stated objectives. Second, the economic justification of the policy based on these objectives is not clear. As discussed in the

⁷ Division 355, Income Tax Assessment Act.

previous section, these are not theoretically valid rationales for government interventions (increased exports and attracting firms to Australia can both be thought of as a form of increasing Australia's international competitiveness).

Wider government objectives

In 2014, the Australian Government launched its Industry Innovation and Competitiveness Agenda (IICA) as part of its Economic Action Strategy. Through the IICA, the government aims to achieve four overarching goals:

- a lower cost, business friendly environment with less regulation, lower taxes and more competitive markets
- a more skilled labour force
- better economic infrastructure
- industry policy that fosters innovation and entrepreneurship.

In the area of industry policy, the agenda stated that policies will be reviewed with an aim to increase the commercial returns on research investments. The actions described in the agenda focused on grant programmes, activities to encourage exports, a review of regulations relevant to establishing start-ups and running small businesses, improving incentives for research and industry collaboration, and focusing research in priority areas.

As a result of the IICA (and specifically the aim to increase commercial returns from research), the government launched the Boosting the Commercial Returns to Research strategy. The strategy identified science and research priority areas, improved grant programmes, launched reviews of research training arrangements and the R&D TI (through the Tax White Paper) and established an online toolkit for intellectual property. The strategy also aimed to identify further areas for collaboration and opportunities to consolidate research programmes.

The R&D TI is not specifically included in the IICA; nor is it raised in detail in the strategy, beyond being recommended for a review as part of the Tax White Paper. However, the R&D TI is consistent with the overall aims of government policy by providing general support to R&D activities in Australia.

On 7 December 2015, while this review was being prepared, the Australian Government released the National Innovation and Science Agenda (NISA; Commonwealth of Australia 2015b), which is a long-term agenda comprising a suite of measures targeted at changing Australia's innovation culture. It builds on existing initiatives designed to help Australian innovators and entrepreneurs. The R&D TI is consistent with the aims of the NISA, and the measures included in the NISA will be complementary to the R&D TI, particularly in encouraging researcher–industry collaboration.

Approach to this evaluation

Evaluation framework

This evaluation addresses three core questions:

- How effective is the programme?
- Is government intervention appropriate?
- How efficient is the programme?

These interrelated concepts are brought together in this evaluation in an economic framework, as set out in Chart 2.2.

Effectiveness

The R&D TI essentially lowers the cost to firms of conducting R&D. To the extent that R&D investment decisions are determined by financial constraints, the incentive is expected to increase firms' spending on R&D. The extent to which that spending increases in response to the R&D TI is referred to as the *additionality* of the programme. The additionality rate (the amount that R&D expenditure increases for every dollar of incentive provided) determines the effectiveness of the programme.

The programme would be judged effective if additionality is greater than 0, but most effective if the additionality is greater than that induced by alternative policy options.

- If the R&D TI fails to induce R&D, it is deemed to be ineffective.

Appropriateness

Increased R&D spending brings benefits to the economy via two avenues:

- benefits to the investing firm from private returns on the additional R&D conducted
- spillover benefits (that is, benefits to the wider economy or other firms).

Spillover benefits to the wider economy include lower prices for goods produced using a more efficient production process; spillover benefits to other firms can occur when knowledge generated through R&D by one firm is used, or added to, by another firm.

The aim of the programme is to increase the spillover benefits from R&D to society. The existence of spillovers from induced R&D is evidence of the appropriateness of the programme.

- The R&D TI programme is appropriate if it induces R&D that leads to spillovers.

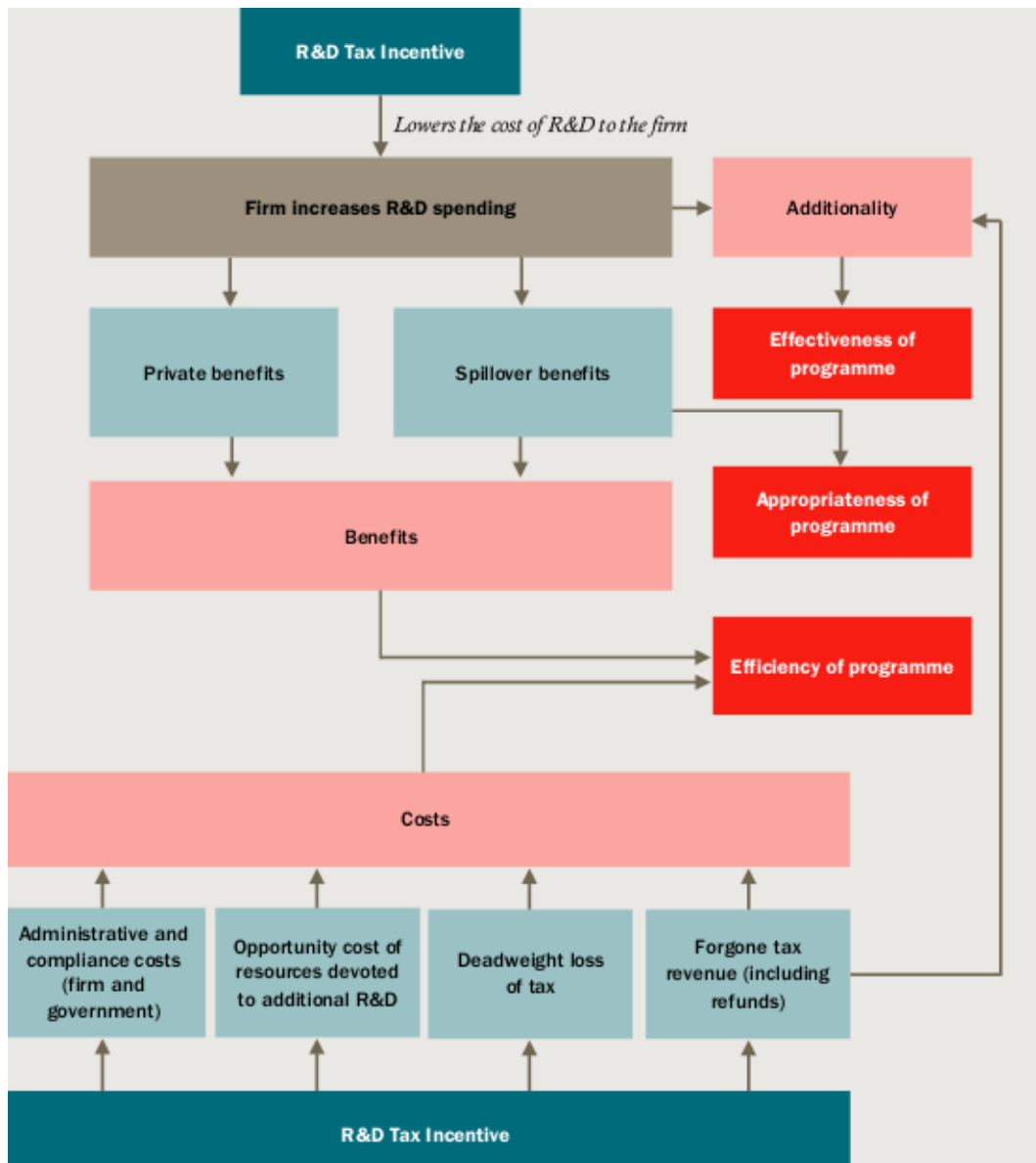
Efficiency

The benefits of the R&D TI programme come at a cost. Comparing the total benefits with total costs provides an indication of the efficiency of the programme. The costs of the programme include the forgone tax revenue (and the refunded tax under the 45% refundable tax offset part of the programme), the deadweight loss associated with this

forgone revenue (also known as the excess burden or allocative inefficiency, which measures the economic cost of tax), the opportunity cost of resources devoted to the additional R&D conducted, and the administrative and compliance costs for the scheme (both to firms and to the government).

- The minimum requirement for the programme to be considered efficient is for the benefits of the R&D TI to be greater than the costs.

Chart 2.2 Evaluation framework



Source: The CIE.

Benefits and spillovers

The benefits of the R&D TI assessed in the review are measured in terms of the surplus generated. The surplus is the benefits realised after accounting for the costs associated with the new activities.

Benefits from increased levels of R&D are expected to be both private and public. The benefits (that is, the outputs or results of induced R&D) can be classified as:

- direct (or private) benefits
- spillovers (or public benefits, including flow-on benefits).

Direct benefits to investing firms

Direct benefits are realised by the firm that is investing in the R&D. In return for the expenditure on R&D, the firm is expected to earn a greater surplus from one or more of:

- sales of new or better products
- cost savings from a new production process
- sales of intellectual property developed.

A firm investing in an R&D project expects some sort of return on the investment. It may be faced with a number of potential R&D projects and will choose to invest in those from which the return is expected to be greater than the cost of the investment. While some projects would be undertaken irrespective of the R&D TI, the incentive effectively lowers the cost of an R&D project to the firm. This means that other R&D projects may become viable, given the lower cost.

Spillovers or public benefits

Spillover benefits accrue to those that have not directly invested in the R&D but benefit from the results. The value of spillovers is the extent to which benefits to society as a whole are greater than private benefits (this is shown in Chart 2.1, as the MB_S curve lies above the MB_P curve at every level of research expenditure). Spillovers are specifically recognised in the legislation in the conditional clause ‘where the knowledge gained is likely to benefit the wider Australian economy’.

Spillovers may be realised through a very wide range of pathways:

- Competitors of the R&D investing firm in the same industry may receive some flow-on benefit through the adoption and diffusion of the new technology. The benefit might be achieved through the movement of trained staff, the publication of research findings or product or service imitation. However, these competitors may also incur costs if their products are displaced in the marketplace.
- Commercial customers of the investing firm may also receive flow-on benefits if the R&D project improves their input efficiency, the quality and market position of their own products, or both. They may receive benefits in the form of a better quality product, a cheaper price, or both.
- Broader spillover benefits could arise if the R&D project makes a wider contribution to knowledge flows through the economy. It may spur on further R&D or the

development of other products, services or processes in Australia. These types of spillovers will depend critically on the generality, applicability and potential rate of diffusion and take-up of the technology or process through the economy.

It is the presence of spillovers that justifies government support for commercial R&D, but not all R&D results in spillovers. In this review, we attempted to quantify the extent to which the additional R&D induced by the R&D TI generates spillovers.

For all examples of spillovers, the relevant factor considered is the marginal surplus generated by the R&D—that is, the consumer or producer surplus produced when the value of a good is greater than the cost.

‘Job creation’ and ‘increased exports’ are often touted as spillovers, or benefits to the wider community, and therefore justifications for government support to R&D. There are two important points to consider here. First, we need to consider the benefits of jobs and exports to parties *external* to the firm investing in the R&D. Second, we need to consider a measure of *surplus*.

The analysis conducted for this review was consistent with the recommendations in the *Handbook of cost–benefit analysis* (Department of Finance and Administration 2006) and the *Cost–benefit analysis guidance note* from the Office of Best Practice Regulation (OBPR 2014). The handbook and other best practice guides to cost–benefit analysis recommend that analysts assume that labour is fully employed and therefore any jobs created by a project or policy will be filled by people currently employed in other positions. Under this assumption, there would be no net increase in employment due to the R&D TI. Individuals would be enticed to new jobs through higher wages (a benefit to workers but a cost to firms). This assumption is supported by the finding in PC (2007) that there is no long-term trend in unemployment rates.

Similarly, for an increase in exports due to the R&D TI to be included in the measure of spillovers, it should be measured based on the additional surplus realised by firms that have not received the R&D TI. The economy-wide impact of an increase in exports is complex and needs to be considered in a general equilibrium framework. By increasing the productivity of firms in Australia (through the direct and indirect impacts of research), the R&D TI would be expected to increase the competitiveness of Australian firms relative to firms in other countries (taking as given, and unchanging, the policies in other countries). This productivity improvement may drive an increase in exports. Any such increase will tend to drive a currency appreciation, which will make Australian exports more expensive for foreigners, but Australian imports relatively cheaper. The overall impact on the welfare of Australians is unclear without further specific analysis.

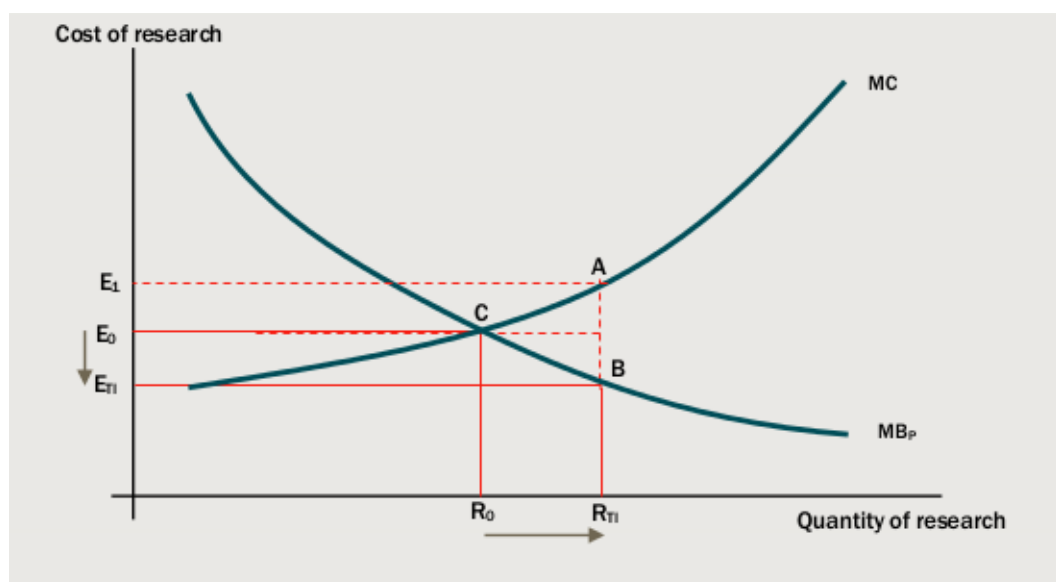
Further discussion of spillovers, approaches to estimating the rate of spillovers from R&D and estimates in the literature are discussed further in Chapters 3 and 8 of this report.

Additionality

The R&D TI effectively lowers the cost of R&D and therefore would be expected to drive an increase in R&D. Additionality is the extent that the R&D TI increases the level of R&D beyond what is expected to occur in the absence of the policy.

The calculation of the additionality rate is illustrated in Chart 2.3. The R&D TI lowers the cost of research, so firms will increase the amount of research they conduct from the initial R_0 to R_{TI} . In this illustration (with increasing marginal costs of research), this requires a unit subsidy equal to the difference between E_1 and E_{TI} . The value of the incentive received by firms is given by the area E_1ABE_{TI} (the total amount of R&D multiplied by the effective subsidy). The value of the additional R&D due to the incentive is given by the area R_0CAR_{TI} . The additionality rate (the increase in R&D expenditure per dollar of incentive provided) is given by $\frac{R_0CAR_{TI}}{E_1ABE_{TI}}$.

Chart 2.3 Definition of the additionality rate



Data source: The CIE.

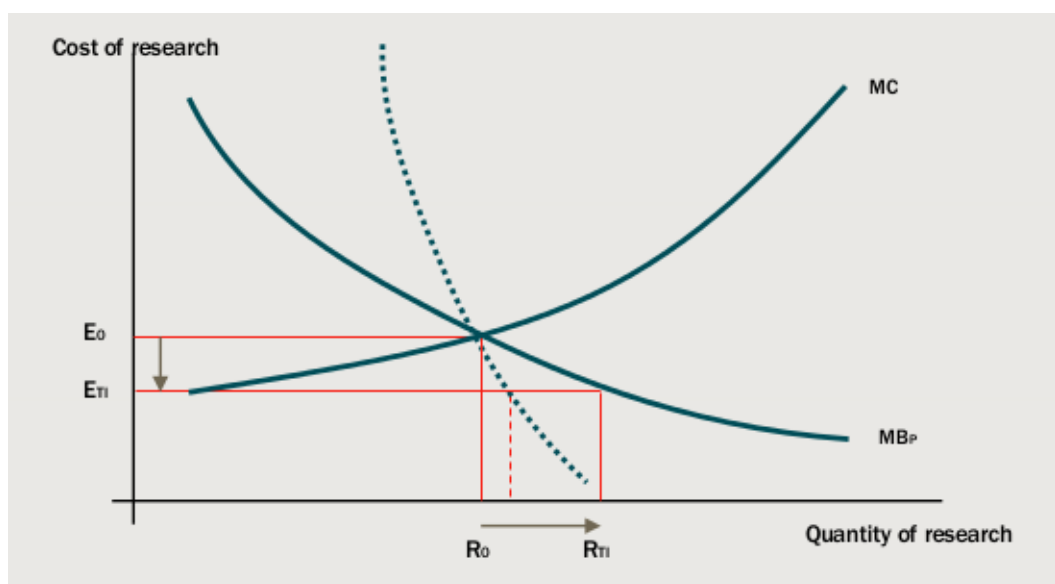
The magnitude of the change in R&D activity in response to a change in the cost of R&D is determined by the slope of the marginal benefit of R&D curve faced by firms. The marginal benefit curve is downward sloping (that is, there are diminishing returns to R&D), as illustrated by the curve MB_P in Chart 2.4. The slope of the marginal benefit curve is determined by the opportunities for research available to the firm and the expected rate of return from R&D.

A firm initially makes a decision to undertake R&D activities up to the point R_0 , where the marginal benefit (from the firm's perspective) from those activities is equal to the marginal cost. The R&D TI effectively lowers the cost of the R&D activities by the amount $(E_0 - E_1)$. This leads to the firm increasing R&D to the point R_{TI} . The increase in R&D outputs from R_0 to R_{TI} is the additional R&D that occurs due to the tax incentive.

A steeper, more vertical, marginal benefit curve means that a firm is less responsive to price changes (for example, because it has fewer research opportunities and therefore

requires a large price change to make additional R&D worthwhile). For the same price reduction stemming from the R&D TI, a firm with a steeper marginal benefit curve would increase its R&D activities by less (see the dotted lines in Chart 2.4). Conversely, a flatter marginal benefit curve would lead to a greater increase in R&D in response to the same price change.

Chart 2.4 Firms' response to R&D Tax Incentive



Data source: The CIE.

An additionality rate of 0.5 would mean that for every dollar of incentive provided the level of R&D expenditure would increase by 50 cents. The concept of additionality is addressed in the object of the legislation through the clause 'to conduct research and development activities that might otherwise not be conducted'.

Additional research may be achieved by allowing firms to bring forward planned R&D expenditure, which then allows for additional R&D expenditure in the future, or by enabling firms to invest greater resources in the same R&D project to achieve a better outcome.

Chart 2.5 illustrates what various additionality rates mean for the level of R&D conducted and the means by which the R&D is funded.

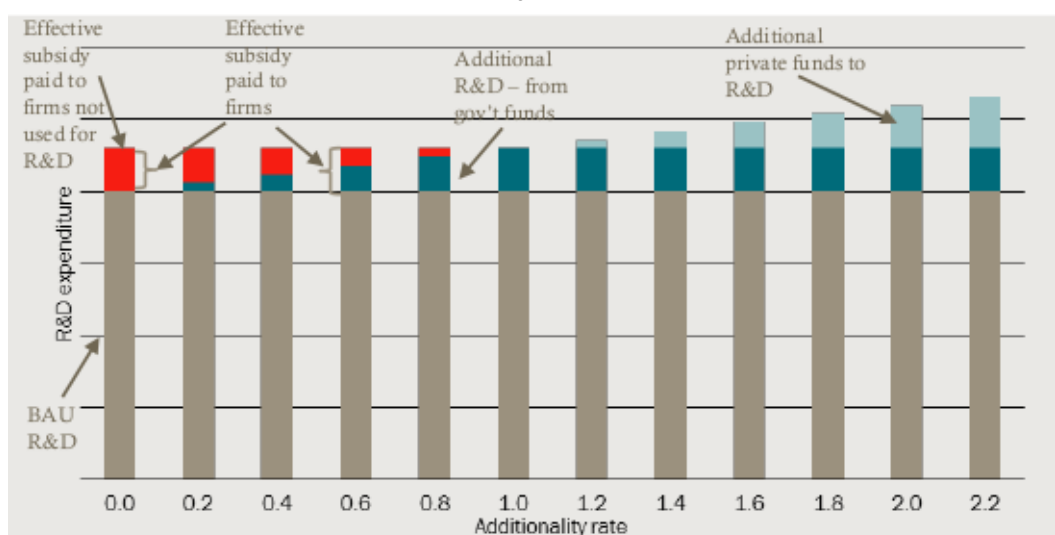
- The lower (tan) section of each bar shows the level of R&D that would be undertaken regardless of the R&D TI programme being in place—the business-as-usual (BAU) level of R&D. For this level of R&D, firms have determined that the benefits to them from undertaking the R&D are expected to be greater than the costs. As the R&D TI programme is currently in place and has been for some time, it is not possible to observe this level of expenditure.
- Under the R&D TI programme, the government effectively pays firms a subsidy by reducing the amount of tax they are required to pay (or, in the case of a small firm for which the amount of its offset exceeds its tax obligation, providing a tax refund). When additionality is 0, this subsidy does not induce any additional R&D. This case is

shown in the first bar. Here, the total value of the subsidy (shown by the red area) is absorbed by the firm and the level of R&D conducted remains at the BAU level.

- If the additionality rate is greater than 0, some amount of the effective subsidy paid under the R&D TI is used to conduct additional R&D. The extent to which the funds are used for additional research increases with the additionality rate (the dark blue areas in Chart 2.5). For additionality rates between 0 and 1, there is still some amount that firms receive from the government that is not used for additional R&D. The total amount of R&D conducted (tan and blue bars) can be observed through R&D expenditure statistics; however, the split between BAU and additional R&D is not known without further information about additionality.
- Finally, it is possible that the additionality rate is greater than 1. In this case, the full amount of the effective subsidy is directed towards additional R&D *and* the firm also contributes further funds to R&D. This circumstance may arise if, for example, a firm has some funds for R&D but does not have enough to conduct a particular project without the R&D TI and so does not invest in R&D. The finance made available through the R&D TI means that the firm is able to undertake the project and use both the amount of the effective subsidy and additional internal funds (this additional internal funding is shown by the light blue bars in Chart 2.5).

As shown in Chart 2.5 (which is drawn to scale for the 45% incentive, assuming a tax-paying firm), the level of additional R&D induced by the R&D TI is small relative to the BAU R&D expenditure.

Chart 2.5 Illustration of various additionality rates and R&D expenditure



BAU = business-as-usual.

Source: The CIE.

The requirement for additionality, as described in the objective of the legislation, implies that the induced R&D should be new R&D that would otherwise not be conducted because of an uncertain return from the activities. One interpretation of this provision would be that R&D that would have otherwise been conducted overseas is not the target of the policy. The OECD (2015) specifically noted that R&D tax incentive policies should be targeted at young, innovative firms and stand-alone domestic firms, and skew

benefits away from multinational firms. This, and other aspects of additionality, are discussed further in Chapter 3.

3 Literature review

Australia is one of many countries that support business R&D through tax offsets. Australia's policy design compares favourably with international benchmarks; however, those benchmarks do not look at empirical evidence on the outcomes of alternative schemes. Tax offsets are often (including in Australia) used in combination with other R&D policies. The characteristics of such alternative policies mean that they are suited to meeting different objectives.

Estimates of additionality in the literature range from very low up to more than 2. The additionality rate for the R&D TI was estimated, using econometric methods, as between 0.8 and 1.9.

The PC has previously concluded that it is not possible to obtain accurate estimates of the social return on business R&D in Australia (spillovers) due to measurement and methodological issues. Its best estimate was that the elasticity of multifactor productivity for R&D is around 0.02. Other studies using an intangible capital approach failed to find evidence of spillovers from business expenditure on R&D arising from tax incentives.

Cross-country comparison of innovation incentives

Many countries have implemented tax-offset or similar schemes in an effort to support R&D. A review of policies in 15 countries⁸ by Deloitte (2014) found that Australia and most other countries use incentives that are embedded in the tax system. These measures allow companies to determine the R&D they perform. (In addition to these measures, some countries also provide direct grants.)

Germany is the only country included in the comparison that does not have tax system measures, as it provides only grants. Countries that do not have R&D tax-offset schemes (not included in the policy review) include New Zealand and Finland.

The OECD (2015) calculated cross-country data on tax subsidy rates for R&D by firm size and firm performance.⁹ Chart 3.1 shows the subsidy rates for Australia compared to similarly developed countries and our significant trade partners in Asia:

⁸ Australia, Austria, Belgium, Canada, France, Germany, Ireland, Israel, Italy, Japan, the Netherlands, Singapore, South Korea, the UK and the US. Appendix B of this report summarises the high-level details of the incentive schemes.

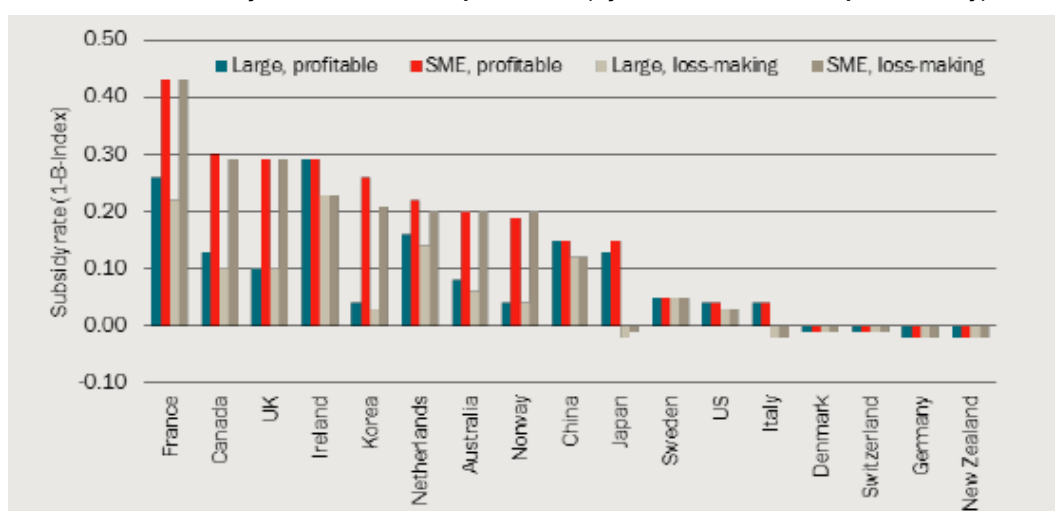
⁹ A subsidy rate is defined as 1 minus the B-index, a measure of the before-tax income needed by a 'representative' firm to break even on US\$1 of R&D outlays. This marginal measure of tax

- Australia's tax subsidy for R&D conducted by large firms (0.08) is about average (0.09).
- Australia's tax subsidy for R&D conducted by small firms (0.2) is more generous than the average (0.15).

Australia is consistent with a number of other economies in providing incentives that specifically target small to medium enterprises (SMEs) by providing a greater level of support to SMEs than to larger firms.

However, Israel appears to provide more incentive for larger companies in the form of extra tax breaks for large companies that undertake R&D in that country (see Table B.1 in Appendix B).

Chart 3.1 Tax subsidy rates on R&D expenditure (by firm size and firm profitability)



Data source: OECD.

Policy objectives and programme design

In its assessment of innovation-specific policies, the OECD (2015) found that R&D tax incentives should be designed to meet the needs of young, innovative firms and stand-alone firms without cross-border tax planning opportunities (or, in other words, it should support firms that are not multinational corporations). R&D tax incentives tend to favour incumbent firms and slow down the reallocation of resources to small firms (Bravo-Biosca et al. 2013, cited in OECD 2015). Large multinational firms are often able to extract significant benefits from R&D tax incentive programmes through tax shifting and internationally optimising their tax affairs.

To address this, policies should aim to ensure that domestic firms are not at a disadvantage to the larger multinationals. For example, providing refundable tax offsets and carry-forward provisions ensures that small firms that are not yet profitable are able to benefit from the programme.

support may differ from the average tax subsidy rate if ceilings and thresholds apply and some firms are prevented from claiming extra support.

Cross-country benchmarking of R&D incentives

The most comprehensive cross-country comparison and benchmarking exercise of different incentives for R&D that the CIE is aware of was by the European Commission (EC 2014).

The authors of that study identified and evaluated 83 separate incentive programmes for R&D in 33 countries (the members of the European Union, along with Canada, Israel, Japan, Norway and the US).¹⁰ The incentive programmes were split into six categories:

- tax credits (such as the R&D TI)
- enhanced allowances (in which R&D expenses can be deducted from taxable income at an inflated rate)
- accelerated depreciation programmes
- reduced tax rates
- patent boxes
- hybrids (combinations of enhanced allowances and accelerated depreciation).

Each incentive programme was evaluated for three broad categories: scope (including the type of incentive and costs covered), targeting (including the characteristics of firms that receive the incentive) and organisation (including administrative practices and whether or not evaluations of the programme are conducted). Within the scope, targeting and organisation categories, there were 5, 10 and 7 subcategories, respectively. Each subcategory was given a score (1 for 'best practice', 0 for 'neutral' or -1 for 'not recommended'). The average subcategory score determined the score for the broad category.

Each incentive programme received an overall score that was a function (described in equation 1) of its broad category scores relative to the average scores for those categories across other countries. All 'tax credit' programmes were benchmarked against other tax credits, enhanced allowances were benchmarked against other enhanced allowances, and so on.

The overall score for each incentive programme (programme '*i*') was calculated as in Equation 1. In this equation, 'mean' refers to the mean across all countries for a given category. The approach used gave a double weighting to the scores for the 'organisation' category, which was justified by the authors because 'scope' and 'target' are theoretical, while 'organisation' is practical. Giving double weight to 'organisation' thus gave the overall score an even focus on theoretical and practical aspects.

$$\text{Overall score}_i = \frac{1}{4} \left(\frac{\text{scope}_i}{\text{scope}_{\text{mean}}} + \frac{\text{target}_i}{\text{target}_{\text{mean}}} + 2 * \frac{\text{organisation}_i}{\text{organisation}_{\text{mean}}} \right) \times \frac{1}{4} (\text{scope}_{\text{mean}} + \text{target}_{\text{mean}} + 2 * \text{organisation}_{\text{mean}}) \quad [1]$$

¹⁰ The countries with the highest number of separate programmes were Spain and Japan, which each have six separate programmes.

Table 3.2 shows the average scores (across countries) for tax credit programmes.

Table 3.2 Average scores for tax credit programmes

Component	Mean score
Scope	0.47
Target	0.54
Organisation	0.25

Source: EC (2014).

‘Best practice’ versus ‘not recommended’ R&D incentives

Table 3.3.3, Table 3.3.4 and Table 3.3.5 describe ‘best practice’ and ‘not recommended’ policy settings for R&D tax incentives. These recommendations were used for benchmarking programmes in EC (2014).

Table 3.3 Benchmarks for the scope of R&D incentives

Subcategory	'Best practice'	'Not recommended' (or 'neutral')	Comments
Tax credits	Tax credit incentive	Neutral: enhanced allowance incentive	Tax credits are preferred from an administrative point of view because (to maintain the desired level of support for R&D) they do not need to be adjusted when the corporate tax rate changes. In contrast, enhanced allowances need to be adjusted when the corporate tax rate changes, as the support for R&D provided by those measures is a function of the corporate tax rate.
Inputs or outputs	Targets R&D inputs	Targets R&D outputs	▪ Evidence suggests that incentives that target inputs (expenditure on R&D) induce more R&D. ▪ Incentives that target outputs (income or assets generated by R&D) may simply be inducing the relocation of intellectual property (IP).
Volume based	Incentive for volume of (or total) R&D	Incentive for incremental R&D	▪ If firms plan R&D expenditure several years ahead, incremental schemes may distort this expenditure by restricting its optimal time path. ▪ Incremental schemes are administratively more complicated.
Expenditure covered	R&D wages	Neutral: total R&D expenditure Not recommended: expenditure on IP rights	▪ Incentives should apply to expenditure that generates the largest spillovers. ▪ R&D workers who change their employment are an important channel for generating spillovers; furthermore, incentives on wages have low compliance/administration costs. ▪ Other types of R&D expenditure may have fewer spillovers. ▪ Expenditure on IP rights reduces spillovers, as those rights reduce/delay the diffusion of knowledge.
Novelty	Incentive for R&D that is 'new to the world'	Incentive for imitation	'New to the world' R&D is likely to have the largest social returns (spillovers).

Sources: EC (2014); The CIE.

Table 3.4 Benchmarks for the target of R&D incentives

Subcategory	'Best practice'	'Not recommended' (or 'neutral')	Comments
Region	No targeting	Targeting or different/specific design elements for different regions	- Targeting may cause some R&D to switch regions, and may reduce total R&D if this reduces economies of scale. - Targeting may increase administrative and compliance costs.
Legal form	Common rate for all entities	Exclusion of firms with foreign ownership	Exclusions may reduce the R&D undertaken (generally), and may be particularly harmful if they reduce foreign direct investment inflows to R&D.
Firm size	No targeting on firm size	Neutral: targeting of SMEs Not recommended: Targeting at different large, multinational firms	Helping small firms is not necessarily desirable: - There is only mixed evidence that small firms respond more to incentives than large firms. - Spillovers for large firms are potentially larger. Large firms have better access to finance and therefore should not be targeted.
Field/type of technology	No targeting	Targeting	There is no clear evidence that spillovers are different across different sectors/technologies.
Firm age	Target young firms	Neutral: no targeting Not recommended: target incumbents	- Young firms face more difficulties obtaining finance for R&D; targeting helps to alleviate this. - Supporting large firms reduces incentives for new firms to innovate, reducing competition.
Minimum R&D expenditure	No minimum	A very high expenditure threshold	- Minimum expenditure requirements may bias incentives against small/young firms, in which R&D budgets may be lower; they may favour larger companies and reduce competition. - Minimum expenditure requirements may reduce administration costs of the programme (in terms of per dollar of tax offset provided).
Brackets and ceilings on R&D expenditure	No brackets	Neutral: ceilings Not recommended: lower rate for smaller amounts	Brackets and ceilings on expenditure: - indirectly target firm size (as R&D for small firms tends to be relatively small), and there is no justification for this - may distort R&D planning by firms, as there is an incentive to time R&D spending so as to maximise tax benefits.

			Ceilings are treated as neutral, as they have the practical advantage of helping to control the budget of the programme.
Subcategory	'Best practice'	'Not recommended' (or 'neutral')	Comments
'Negative tax' (refunds)	For young firms	No negative tax	A 'negative tax' involves cash refunds when a firm undertakes R&D but does not make a profit. This is likely to be particularly beneficial for young firms, which may not be profitable initially.
Carryover provisions (carry over tax losses)	Yes	No	Carryover provisions allow firms to take full advantage of the incentive and may increase flexibility in R&D expenditure decisions, as there can be a considerable lag between R&D and generated profits.
Collaboration ^a	Incentive for collaboration with public institutes	Upstream R&D cooperation between large competitors	■ Collaboration with public research institutes may increase spillovers because results are more likely to be published. ■ Collaboration between incumbents might not increase spillovers and may reduce competitive pressure.

^a Not included in numerical benchmarking exercise.

Sources: EC (2014); The CIE.

Table 3.5 Benchmarks for the organisation of R&D incentives

Subcategory	'Best practice'	'Not recommended' (or 'neutral')	Comments
Stability ^a	Fixed design for at least 5 years	Large changes announced in budgets	Frequent and substantial policy changes are likely to strongly reduce the effectiveness of the policy, as predictability helps firms incorporate policy into their R&D plans.
Generosity ^a	Uncertain	Over-subsidising	Evidence on optimal generosity is lacking.
Decision/refund time	Minimum decision time	More than 1 year after R&D expenditure	If the decision on the refund comes long after R&D expenditure has been made, young firms might not respond to the policy. For young, financially constrained firms, decisions and reimbursement should be as quick as possible.
Electronic application and one-stop agency	Yes	No	- Best practice reduces the administrative and compliance costs of the scheme. - Start-ups may be discouraged to apply for the scheme if they face uncertainty over compliance costs.
Public consultation	Yes	No	Public consultations can help government improve the programme.
Subcategory	'Best practice'	'Not recommended' (or 'neutral')	Comments
Evaluation	Yes, preferably planned and regular	No	For a policy to become and remain effective, it is necessary to organise regular evaluations.
Synergy ^a	Complementary policy instruments	Overlap	- Combining tax incentives with direct support can target support (overall) towards projects with the highest social returns. - Overlapping policies increase administration costs and reduce the efficiency of expenditure.

^a Not included in numerical benchmarking exercise.

Sources: EC (2014); The CIE.

Australia's R&D Tax Incentive benchmarked against other tax offset schemes

Here we use the benchmarking method of EC (2014) to give Australia's R&D TI a score that can be compared to those of other tax incentives across the world. A score of 1 corresponds to best practice and –1 to 'not recommended' practice. A score of 0 is neutral.

Table 3.6 Australia's R&D TI scope scores

Subcategory	Score	Comments on R&D TI
Tax credits	1 (best practice)	Tax credit
Inputs/outputs	1	Targets inputs (expenditure on R&D)
Volume based	1	Volume based
Expenditure covered	0 (neutral)	R&D expenditure is broadly defined (not just as wages)
Novelty requirement	0	Knowledge generated by R&D might not necessarily be 'new to the world'
Overall score	0.6	<i>(average of subcategory scores)</i>

Source: The CIE.

Table 3.7 Australia's R&D TI target scores

Subcategory	Score	Comments on R&D TI
Region	1 (best practice)	No targeting of regions
Legal form	0	- Non-incorporated entities are explicitly ineligible. - Where a firm is incorporated in Australia, no specific exclusions for foreign ownership. - Foreign incorporated firms are eligible if they have a 'permanent establishment' in Australia under a tax treaty; this is taken to include most foreign incorporated firms in Australia.
Firm size	0	Incentive for SMEs is more generous—targeting SMEs
Field of activity	1	No targeting of activity/technology
Firm age	0	No targeting of firm age
Minimum	–0.5 (not recommended)	Minimum exists, but relatively small
Brackets	0	High ceiling on amount of R&D expenditure
Negative tax	1	Credit is refundable for small firms
Carryover	1	Non-refundable credit (for large firms) can be carried forward
Overall score	0.39	<i>(average of subcategory scores)</i>

Source: The CIE.

Table 3.8 Australia's R&D TI organisation scores

Subcategory	Score	Comments on R&D TI
Decision time	1	Self-assessment, so relatively fast; pre-approvals available
Electronic application	1	Online application available
One-stop application	-1	- Application process is done with AusIndustry - Tax return is responsibility of ATO
Public consultation	1	Consultations with National Reference Group
Evaluation	1	Regular evaluations undertaken
Overall score	0.6	(average of subcategory scores)

Source: The CIE.

Based on our assessment, Australia's R&D TI ranks favourably among the tax credits evaluated in EC (2014). It would rank 5th out of 32, behind France, Norway, Canada and the Netherlands, but in front of Ireland and Denmark (Table 3.9).

Table 3.9 Cross-country benchmarking of tax credits (Australia and top 6 in EC 2014)

Country	Incentive	Overall score	Category scores		
			Scope	Target	Organisation
France	Jeunes Entreprises Innovantes	0.78	1.00	0.67	0.60
Norway	SkatteFUNN	0.73	0.40	0.39	0.80
Canada	SR&ED	0.66	0.80	0.44	0.55
Netherlands	WBSO	0.65	0.60	0.50	0.60
Australia	R&D TI	0.64	0.60	0.39	0.60
Ireland	R&D tax credit	0.61	0.27	0.78	0.60
Denmark	Skatte kreditordningen	0.59	0.40	0.44	0.60

Sources: EC (2014); The CIE.

Additionality requirements across countries

Under volume-based measures, such as that used in Australia, tax credits are provided not only for additional R&D but for all eligible R&D. Therefore, there is no requirement for authorities to assess the additionality of projects. While the object of the Australian legislation implies a desire to target additional R&D, there are no specific clauses in the body of the legislation that set out such a requirement.

An incremental scheme is applied in Italy, and incrementally based measures are used in combination with volume measures in Belgium, the Czech Republic, Portugal, Japan, Ireland, Spain and the US. Those schemes aim to target additional R&D. Due to difficulties in establishing the additionality of a particular project, they use metrics such as R&D relative to historical averages as a proxy for additionality.

Since schemes are either volume based or incremental relative to historical R&D activity, authorities do not generally assess the additionality of individual projects. Rather, they focus on the authenticity of the R&D expenditure claimed.

Companies in Australia access the R&D TI on the basis of 'self-assessment', which means that their R&D activities are in the main not formally audited before they receive benefits (although their R&D claim can be audited afterwards). AusIndustry undertakes a pre-registration review process, which involves compliance reviews of a select group of companies as part of its consideration of their registration applications. However, those reviews are focused on identifying acute risks of noncompliance and fraud to protect the integrity of the programme. They do not assess the additionality of the R&D.

In contrast, to access tax credits for R&D in Norway companies must have their R&D activity approved by the Research Council of Norway. Despite a rigorous assessment of individual projects prior to registration, the council does not explicitly check whether tax credits are leading to R&D that would not have otherwise occurred. Rather, it is concerned with whether the project is targeted and limited, whether it aims to generate new knowledge or new skills, whether it revolves around the development of new or improved products, services or production processes, and whether it brings benefits to 'now'.¹¹

Evaluation of programme additionality

In the benchmarking exercise undertaken in EC (2014)—which considered 83 separate R&D incentive schemes across 33 countries—R&D incentive schemes were given a score for 'evaluation'. A score of 1 means government evaluations of the schemes occur (and are preferably planned and regular), while -1 means evaluations do not occur (0 is some sort of intermediate result that is not explained). Under this score system, the authors gave 11 R&D incentive schemes in seven countries a score of 1 for evaluation. This implies that the vast majority of R&D incentive schemes are not subject to regular, thorough, robust government evaluations. It is probably reasonable to infer from this that the vast majority of R&D incentive schemes, where they are evaluated at all, are not evaluated for 'additionality'.

EC (2014: Tables 2.1 and 2.2) provides the results of various studies that do measure the additionality of R&D schemes. One of those studies, HMRC (2010), is attributed to a government department; the rest are attributed to individual authors. It is possible that a number of the studies were undertaken by the authors at the request or direction of government departments. In any case, the EC (2014) assessment of this literature (as discussed in the literature review) is that the more reliable studies conclude that the additionality of R&D incentive schemes lies between 0 and 1.

¹¹ <http://www.skattefunn.no/prognnett-skattefunn/Soknadsprosessen/1247145113245> (accessed 4 January 2015, translated in Google Translate).

Case study: Evaluation of Norway's SkatteFUNN

The benchmarking undertaken in EC (2014) examines the characteristics of various R&D incentive programmes against a theoretical best practice, but does not report the practical results achieved by the programmes. The lack of comprehensive evaluations of programmes may be one reason for this.

Norway's SkatteFUNN programme was ranked as the second highest programme in the EC (2014) benchmarking exercise. The overall high score of this programme (along with the score for the highest ranked programme—France's Jeunes Entreprises Innovantes) was driven by the scores for organisation. Both of these programmes scored well for organisation, but less well for targeting. The formula for the overall score gave a double weighting for organisation, which drove this result.

The evaluation of the Norwegian programme is publicly accessible (and the executive summary is available in English). The evaluation found that there was high additionality under the programme but very little evidence of spillovers. This appears to suggest that there were limited public benefits to justify the existence of the programme. However, the evaluation specifically notes that the primary justification of the scheme is to address capital market imperfections, which the policy tackles effectively. Nevertheless, the evaluation does not include a comprehensive cost–benefit analysis of the programme to determine its efficiency.

Analysis of the results of evaluations does not enter into the benchmarking process conducted for EC (2014).

Reviews of other tax incentive programmes

Canada

An evaluation of a Canadian incentive for R&D, the Federal Tax Credit for Scientific Research and Experimental Development (SR&ED) programme, was completed by Parsons and Phillips (2007).

The authors derived a calculation for the net social benefit created by the scheme, which is essentially the surplus created for firms (arising from cost savings on R&D created by the incentive), plus the spillovers generated in Canada, less the distortion created by the taxes used to fund the scheme, less the administration and compliance costs. The authors made some (key) assumptions:

- They assumed additionality of 0.86, in line with the median estimate of additionality in selected studies on Canada.
- The value of spillovers in Canada from R&D generated by the scheme (domestic external return on Canadian R&D) was assumed to be 56% of R&D expenditure, in line with the median estimate of selected Canadian studies.¹²

¹² This figure is also close to the rate recommended by PC (2007) of 65% (equivalent to an elasticity of multifactor productivity for R&D of around 0.02).

- The cost of the distortion imposed on the economy by the taxation used to raise funds for the scheme (the 'marginal excess burden' of taxation) was calculated to be \$0.27 per dollar raised.
- The costs of administration (costs to government) and compliance (costs to firms) incurred by the scheme were estimated to be around \$0.02 and \$0.08, respectively, per \$1 of incentive.

There were three key results from this study:

- With the assumptions already listed, the authors calculated that the SR&ED programme in Canada increases net welfare by \$0.11 for each \$1 of incentive provided.
- This result was very sensitive to the assumptions adopted. For example, the programme was calculated to generate a net welfare loss if additionality fell from 0.86 to 0.71, or if the spillover rate for Canadian R&D fell from 56% to 45%.
- Due to the limited number of studies available, the authors could not estimate confidence intervals for their results. However, they used the available studies to judge reasonable ranges for additionality and spillovers. Within most of those ranges, the SR&ED programme was calculated to be adding to national welfare.

The Netherlands

Lokshin and Mohnen (2009) used a model of dynamic demand for R&D, in which desired R&D capital is a function of R&D costs. This allowed them to assess the short-run and long-run response of R&D expenditure to R&D incentives.

They analysed the Wet Bevordering Speur-en Ontwikkelingswerk (WBSO) incentive for R&D in the Netherlands (a discount on social security contributions that is a function of R&D labour costs). The authors used simulated data to assess this incentive:

- For additionality, the authors used their model. They distinguished between small firms and large firms. In this model, the desired stock of R&D is a function of R&D costs, and year-to-year R&D investment changes as this changes. Overall, their modelled path for R&D expenditure implied that the incentive has additionality (on average, across firm sizes) of just under 0.5 in the long run. In the short run, when firms initially respond to the incentive, additionality (on average, across firm sizes) was just below 1.
- The authors tested the effects of using different spillover rates on the overall benefit of the programme. For all scenarios, the deadweight loss of taxation was assumed to be 30% and compliance costs and administration costs were assumed to be 10% (based on interviews with firm managers and government officials, but also in line with Parsons and Phillips 2007). The highest spillover rate assumed was 50% (broadly consistent with Parsons and Phillips 2007) and, based on that assumption, the authors found that for every €1 of incentive provided under the WBSO, the net welfare gain in the Netherlands was €0.16. This result was similar to that of Parsons and Phillips (2007).

Alternative R&D policies

Ben Bernanke (as Chairman of the US Federal Reserve Board) stated that the rationale for government support for basic research was well established, but that the most appropriate policy for providing the support was not (Bernanke 2011).

Most countries, including Australia, employ a range of different policies for supporting R&D. The rest of this chapter provides brief summaries of the key policy types that are used to support R&D by businesses.

Incremental R&D incentives

A range of alternative policy settings are used in R&D tax offsets schemes. A major area of differentiation is whether schemes are volume based or incremental. The R&D TI is a volume-based measure, meaning that all genuine R&D attracts the tax offset. In incremental schemes, tax offsets are provided only for 'incremental' R&D (some volume-based schemes also offer additional incentives for incremental R&D).

The objective of incremental schemes is to target additional R&D. However, because of the practical difficulties in establishing whether R&D is truly additional, those schemes generally define incremental R&D relative to historical levels. By supporting only incremental R&D, the budgetary cost of incremental schemes in forgone revenue is lower than the budgetary cost of volume-based schemes. The administrative costs of an incremental scheme, though, are greater than those of a volume-based scheme. Under the R&D Tax Concession, incremental R&D was supported through a higher rate of deduction for firms that increased their level of this type of R&D expenditure relative to their average of such R&D expenditure over the previous three years. Feedback from the department was that this incremental measure led to contrived tax arrangements as firms sought to change the timing of their R&D to take advantage of this measure (Department of Industry, Innovation and Science, pers. comm.).

Grants

The most commonly cited alternative to a tax offset to increase private sector R&D activity is a grant programme. Grants may also be seen as complementary to tax offsets in a wider policy environment aimed at increasing private sector R&D. There are pros and cons to a grant programme compared with a tax offset.

Grant programmes in general can be more costly for governments to administer than offset programmes because individual projects need to be assessed and ranked, and it can be costly to promote the programme and engage with firms. Because individual projects or industries are selected, the process can be subject to political pressures and can be criticised for attempting to 'pick winners'. The benefit of a grant programme, from a government perspective, is that the expenditure of the programme is capped and the funding can be targeted to priority areas to maximise spillovers.

From the point of view of firms, a grant-based programme can have very high up-front compliance costs—they have to find the grant programme and apply for the grant with

an uncertain return. Firms may also have concerns about the commercial sensitivity of their projects when submitting applications, and some firms can be excluded from grant schemes based on their industry. However, grant schemes can potentially provide more generous funds and are not subject to audits after the completion of the project. Additionally, grants may be preferred to a tax incentive by individual operators who do not have R&D expenses other than their own time.

A comparison of estimated additionality rates for an Australian grant programme (R&D START) with a tax incentive programme (the R&D Tax Concession) found that the rate under the grant programme was lower than under the tax incentive. This was despite the fact that applicants under the R&D START programme had to demonstrate that their projects could not proceed ‘satisfactorily’ without support (PC 2007).

Australia runs a number of grant programmes for businesses (as well as grants targeted at research organisations). Examples include the Regional Innovation funds, the Australia–China Joint Research Centres, the Australia–Japan Foundation Grant Program, the Enterprise Solution Centre and the Accelerating Commercialisation programme. State governments also run a range of such programmes.

Some programmes also target specific industries, such as the Clothing and Household Textile Building Innovative Capability scheme, the Australian Tropical Medicine Commercialisation programme, the Australian Renewable Energy Agency Research and Development Programme, the New Air Combat Capability—Industry Support Program, and a number of state-based programmes.

Procurement programmes or R&D contracts

Governments can play a role in funding the development of new technologies through R&D contracts. This stimulates private sector innovation and provides the government with new, efficient solutions to its needs. This addresses both of the key policy rationales identified by the PC (PC 2007).

The US Small Business Innovation Research (SBIR) Program requires 2.5% of each department’s budget to be expended through the programme. The programme targets small firms—only those with fewer than 500 employees are able to apply, and most of the funds are awarded to firms with fewer than 25 employees. The programme operates in three stages:

- In the first stage, firms are awarded up to \$150,000 for a feasibility study. Approximately 15% of applicants are successful at this stage.
- Phase 2 pays up to \$1 million for the R&D project. Around half of the Phase 1 firms receive Phase 2 funding.
- In the final phase, the firm commercialises the product, with possible government support from outside the scope of the SBIR Program.

By requiring a certain percentage of an existing budget, the programme is not subject to its own budget line and is therefore independent of the budget process. As a result, it is more politically sustainable (OECD 2010). However, the programme is at risk of crowding out private R&D efforts and is subject to lobbying, and it is administratively

costly to assess projects. It is also costly for firms to prepare applications, which have a low success rate.

Despite a long history, some evaluations of the US SBIR Program have concluded that it is not effective. The evidence suggests that the programme does not generate additional research, and the assessment process is vulnerable to managers trying to pick winners to generate success stories (OECD 2010).

Similar programmes have been implemented in Japan, the UK and the Netherlands but not in Australia.

Industry consortia

R&D corporations are cooperative industry-owned groups that fund R&D for the benefit of their members. Funds may be sourced from levies, membership fees, voluntary contributions, matched government funds, or any combination of them. R&D priorities are determined by industry members, which ensures that they are relevant to firms' ongoing activities and priorities. Through government funding arrangements, governments can also direct funds to priority industries.

Projects funded through these industry consortia tend to be focused on intra-industry benefits rather than inter-industry benefits. It has been argued that the cooperative nature of R&D corporations maximises additionality because firms tend not to support projects that they are performing individually and favour projects that will generate maximum intra-industry spillovers (Webster 2014). The take-up of research is expected to be higher than for research through other government-funded institutions due to the built-in channels for translation and industry ownership of the research.

These types of programmes are useful in industries characterised by small firms that may not have the capacity to undertake significant research projects individually. However, the PC (2011) found that, in the case of rural R&D corporations, the 'overall level of public support for industry focused research is too high given the sound financial reasons that producers or industries would have to fully fund much of this research themselves.'

The government supports 15 rural R&D corporations in Australia that operate under this type of model. In addition to government funds, firms contribute through industry levies. The government also supports 33 cooperative research centres (CRCs), which are industry consortia funded by a combination of industry funds and government grants.

Patent boxes

A patent box or intellectual property (IP) box in Australia would be designed to encourage companies to use Australia as the base to develop and exploit IP. Tax reductions are provided for income derived from products patented in the country with the patent box. Patent boxes have been implemented in 11 European countries and China (de Rassenfosse 2015). Two slightly different approaches have been taken:

- providing a tax break for income derived from IP registered in the country (this incentive is focused on moving production based on patents to the country)
- providing a tax break for income generated by IP initially developed in that country (this provides a greater incentive for innovation in the country).

Administratively, a patent box is relatively simple because it is integrated into the tax system. The greatest cost associated with a patent box is the forgone tax revenue. From a firm's perspective, a patent box is also attractive because it will lower the firm's tax bill. Patent boxes are generally effective only if they offer the lowest tax rate among comparable countries. Therefore, there is significant risk that the use of patent boxes will cause a 'race to the bottom' as tax competition between countries leads to greater use of patent boxes and lower tax rates.

A study on the potential application of patent boxes in Australia concluded that any potential increase in tax revenues from increased IP income in Australia is likely to be low, and lower than the cost in forgone revenue (de Rassenfosse 2015). Patent boxes are also expected to have minimal impact on innovation in Australia. Although they may increase the number of patent applications, those applications are likely to be opportunistic rather than a reflection of increased innovation (de Rassenfosse 2015). While there is a lack of empirical evidence on the impact of patent boxes on innovation and subsequent economic benefits, de Rassenfosse (2015) concluded that the overall return on a patent box regime in Australia was likely to be negative.

Finally, the concept behind patent boxes, by providing a subsidy to the generation of IP, runs counter to the logic of R&D support. As noted in Chapter 2, the primary justification for government involvement in the provision of R&D is to generate a positive externality (spillovers) by increasing R&D above the private market equilibrium. IP protections are another method of addressing the suboptimal output of R&D by internalising the externality (eliminating spillovers to ensure that private parties have the incentive to invest in R&D at the optimal level). Patent boxes provide an additional subsidy (through lower tax rates) to R&D outputs without a clear theoretical justification.

Economic framework

Potentially the most important policies to encourage R&D in the private sector are not specific R&D policies but policies that provide favourable economic conditions that support investment in R&D.

Appropriate economic framework conditions are required for R&D investment, regardless of the presence of the R&D TI or other focused policies. Without the correct environment, other policies may not induce any further R&D. Furthermore, providing the appropriate framework conditions may have a greater impact on R&D investment levels than the R&D TI. Daley et al. (2013) described the framework conditions for the private sector to encourage invention and innovation as including:

- stability and flexibility
- competitiveness
- a competitive corporate tax rate

- appropriate protection of IP rights
- effective human capital.

Table 3.10 summarises some indicators of framework conditions in Australia and OECD+¹³ countries. The table shows that Australia ranks below the OECD+ average for 12 of the 20 indicators. However, Australia ranks comparatively well for indicators of education and skills base and of research workforce (see Tables A6(b) and A8(b) in Department of Industry, Innovation and Science 2015).

¹³ OECD+ refers to the OECD countries and China, Taiwan and Singapore.

Table 3.10 Indicators of framework conditions in Australia

Indicators	Australia's score	OECD+ Average	OECD+ top 5 average	Gap from the top 5 OECD+ performers	Ranking against OECD+ countries
Financing through local equity market, score 1–7 (best)	4.98	4.28	5.43	8%	10th of 37
Ease of access to loans, score 1–7 (best)	3.32	3.12	4.27	22%	18th of 37
Venture capital availability, score 1–7 (best)	3.13	3.35	4.48	30%	24th of 37
Venture capital investments, % of GDP	0.018	0.048	0.175	90%	21st of 29
Early stage venture capital investment, % of GDP	0.007	0.028	0.097	93%	18th of 27
Later stage private equity investment, % of GDP	0.011	0.022	0.08	86%	13rd of 26
Market capitalisation of listed companies, % of GDP	83.8	62.1	132.7	37%	10th of 36
Stocks traded, total value, billion, current US\$	1052	1226	6962	85%	10th of 36
Stocks traded, total value, % of GDP	68.5	38.6	105.4	35%	8th of 36
Stocks traded, turnover ratio, %	84.7	62.2	146.3	42%	9th of 36
Government procurement of advanced tech products, score 1–7 (best)	3.3	3.6	4.5	27%	27th of 37
Firm-level technology absorption, score 1–7 (best)	5.6	5.4	6.1	8%	19th of 37
Entrepreneurial intentions, %	10	12.2	25.6	61%	16th of 31
Buyer sophistication, score 1–7 (best)	3.8	4	4.8	21%	24th of 37
Percentage of final household consumption expenditure on health, communications and education, %	13.1	8.9	15.9	18%	4th of 33
Statutory corporate income tax rates, %	30	25	34	13%	6th of 31
Start-up procedures to register a business, count	3	5	2	50%	4th of 36
Cost of business start-up procedures, % of GNI per capita	0.7	4.3	0.3	150%	9th of 35
ISO 14001 environmental certificates, per billion PPP\$ GDP	24.8	37.7	90.2	72%	19th of 36
Total environment-related taxes, % of GDP	2	2.28	3.69	46%	24th of 35

Source: Department of Industry, Innovation and Science (2015).

Empirical measurement of additionality

Additionality is arguably the most important issue to understand and measure in order to evaluate R&D tax incentive programs.

To determine the additionality of an R&D incentive, the impact of the incentive on a firm's R&D needs to be isolated and measured, holding all other factors constant. This means that the ideal theoretical evaluation of additionality would involve examining the R&D of a firm with and without the incentive (and repeating this experiment as many times as necessary to get a sense of how the impact varies across firms). It is impossible to design an experiment like this in practice (as, at any point in time, a firm can either receive or not receive the incentive). However, Thompson and Skali (2016) suggest that the government could simulate this ideal test of additionality by allocating the R&D incentive randomly to firms, and then comparing the R&D of firms that receive the incentive to the R&D of those that do not. To date, there has been no report in the literature on the performance of such an 'ideal' test.

Tests for additionality and limitations

Economists use various methods that depart from the 'idealised' experiment we described to measure the additionality of R&D incentives. As those methods depart from the idealised method, the question is: how reliable or accurate are the estimates of additionality that they generate?

For example, a very basic method could be to simply compare the R&D of firms that receive an incentive with the R&D of those that do not. This method does not isolate the impact of the incentive for R&D, as firms that receive it are likely to have other characteristics that will affect their R&D. This is a problem of 'selection bias', explained in Table 3.11.

EC (2014) identified general factors that can prevent economists from reliably and accurately measuring the additionality of R&D incentives. Table 3.11 lists and discusses them.

Table 3.11 General factors that can make estimates of additionality unreliable

Factor	Why does this factor cause estimates of additionality to be unreliable?
Reverse causality and endogeneity	In some schemes, larger firms receive relatively smaller R&D benefits than smaller firms (reflecting a view among policymakers that smaller firms are more capital constrained and need more support to undertake risky R&D). If larger firms do more R&D than smaller firms, <i>smaller</i> R&D benefits will be associated with <i>larger</i> amounts of R&D. This makes estimating the impact of the incentive on R&D difficult. (This, along with other factors, is sometimes called 'reverse causality'). To measure additionality, one approach in the literature is to model R&D expenditure or desired R&D capital as a function of R&D cost (which includes the impact of the incentive for R&D) and other variables, including variables related to firm size (such as profits). In this approach, the cost of R&D (which is supposed to be an exogenous, independent variable) will be endogenous (it is determined by the size of the firm). Even if the R&D policy incentive makes no distinction between small firms and large firms, R&D costs may still be endogenous (due to, for example, differences in capital costs). The problem of endogeneity introduces the possibility of biased (inaccurate) parameter estimates. To overcome the problem of endogeneity, EC (2014) noted that researchers use instrument variables. It is up to researchers to argue that their choices of instrument variables are appropriate. EC (2014) noted that the quality of instrument variables differs across researchers.
Selection bias	Due to differences in many factors, including management style, strategy and/or personnel, some firms are innovative and some are not. It is likely that innovative firms will undertake R&D regardless of any incentive <i>and</i> select into (take up) the incentive programme. This means that there is a risk of overestimating the impact of an R&D incentive on R&D, because firms that use the incentive have other factors that also drive R&D. EC (2014) noted that one way to deal with selection bias is to use panel data (along with a model that includes 'fixed firm effects') to examine the R&D of individual firms before and after the introduction of an incentive.
Adjustment costs	It is costly and time-consuming for firms to increase their R&D expenditure in response to an incentive. Economists who do not estimate the long-run impact of the incentive on R&D may make an incorrect estimate.
Relabelling of non-R&D as R&D	Once an incentive is introduced, firms might relabel activities that are not genuine R&D as 'R&D' to take advantage of the incentive. This could lead to an overestimate of the impact of the incentive on R&D.
Changes in input prices	With an incentive, firms may genuinely increase demand for R&D inputs. If the supply of some of those inputs is inelastic, their price will go up but their quantity might not (this could be the case for highly specialised equipment and PhDs). The result could be that expenditure on R&D increases but the 'volume' of R&D does not. In this case, an estimate of additionality could overstate the true impact of the incentive on the firm.
Multiple treatments	In most cases, R&D tax incentives are used alongside other measures to promote R&D. This means that it could be difficult to isolate the impact of the R&D tax incentive.

Sources: EC (2014); The CIE.

Suggested reliable estimates of additionality

EC (2014) noted three studies that provided relatively reliable measures of additionality. The results from those studies are shown in Table 3.12.

Lokshin and Mohnen (2012) and Mulkay and Mairesse (2013)

These studies used structural models to estimate the relationship between the desired stock of R&D and the cost of R&D (which is partially driven by the incentive). EC (2014) noted that these studies applied instrumental variable techniques in a credible way to overcome the problems of endogeneity and selection bias in their structural models.

They calculated the long-run elasticity between the cost of R&D and the desired stock of R&D. To get additionality, they calculated the impact of the R&D incentive on the cost of R&D and used the elasticity to calculate the impact of this on the desired stock of R&D. They then used their model to determine the response of R&D expenditure, which gave them additionality.

Cornet and Vroomen (2005)

According to EC (2014), Cornet and Vroomen¹⁴ used the relatively robust technique of ‘difference-in-differences’ to examine the impact on R&D expenditure of changes in the Netherlands WBSO R&D incentive in 2001. The policy change saw R&D incentives change for only a subset of firms (start-ups). ‘Difference-in-differences’ took advantage of this natural experiment to estimate relatively robust results (by comparing firms in the programme that were subject to the change to firms that were in the programme but not subject to the change). In this approach, the additionality of policy changes could be estimated directly.

Table 3.12 Reliable estimates of additionality

Study	Incentive	Long-run elasticity	Estimate of additionality
Lokshin and Mohnen (2012)	Netherlands WBSO	Average across models: -0.63^a	- Short-run: 1.05 - Declines to 0.5 in long run, but is insignificant
Mulkay and Mairesse (2013)	Tax credit in France	Preferred model: -0.41^a	- Initially low - Climbs to 1 (or just above) in medium term - Long-run: 0.7
Cornet and Vroomen (2005) ^b	Reform in Netherlands WBSO in 2001	–	0.5–0.8 for start-up scheme (significance not stated) 0.1–0.2 general scheme (significance not stated)

^a Long-run elasticity between the desired stock of R&D and the cost of R&D (which is influenced by the R&D incentive). Expected sign is negative, as a fall in the cost of R&D boosts the desired stock of R&D.

^b Study available only in Dutch; results and discussion taken from EC (2014).

Note: Results are statistically significant unless otherwise stated.

Sources: EC (2014); studies as listed; The CIE.

The reviewed literature does not explain *why* the estimates of additionality might be correct. For example, if the estimates in Table 3.12 are correct, and it is true that \$1 of

¹⁴ Study available only in Dutch; results and discussion of study taken from EC (2014).

incentive for R&D induces less than \$1 of extra R&D, why this is the case is not explained. It could be that some firms simply choose to undertake the level of R&D that is needed to keep them competitive (which in some cases might mean that their R&D budget is some function of sales). In that case, an R&D tax credit would induce very little extra R&D, as the R&D decision is independent of the credit. The credit (less the compliance cost) would be a windfall for the firms.

HMRC (2015): a more recent study of additionality in the UK

After EC (2014) was published, HMRC (2015) attempted to measure the additionality of the UK's R&D relief scheme, in which companies receive enhanced deductions for R&D expenditure. The scheme is more generous for small companies.

The authors found that the additionality rate for the UK scheme is 2.35 for large firms (for every £1 of incentive a large firm receives, its R&D increases on average by £2.35) and 1.88 for SMEs. These results—implying very strong additionality—are an outlier relative to most other studies.

The authors noted that their focus was on measuring the 'short-run' elasticity between the price of R&D (influenced by the incentive scheme) and R&D expenditure. This elasticity was used to calculate additionality. Most analysts focus on the long-run effects, as it is acknowledged that it takes time for firms to properly adjust their R&D to incentives.

Thompson and Skali (2016): Additionality under the R&D TI

The department commissioned a study from Russell Thompson and Ahmed Skali at the Centre for Transformative Innovation, Swinburne University of Technology. The objective of the study was to use econometric models to measure the level of additionality under the R&D TI. The analysis used a comprehensive dataset recently established at the ABS—the Extended Analytic Business Longitudinal Dataset (EABLD)—in addition to the Super Main Unit Record File (SMURF). The two datasets provide firm-level panel data for around 6.5 million businesses (at the enterprise group level) including information on sales, wages, R&D investment and turnover. The analysis focused on around 5,500 firms that reportedly conducted R&D prior to 2012 and 2,000 firms that did so in 2012.

Thompson and Skali (2016) represented a first attempt at using this database to assess additionality. As they argued, there is considerably more work that can be done to improve the analysis. Importantly, they made some suggestions about future data collection, which are further picked up in the recommendations in this report.

Thompson and Skali used four different econometric methods to examine the effect of the tax incentive on R&D outcomes.¹⁵ Their analysis relied on the existence of a control

¹⁵ Not all of the techniques used found evidence of a significant impact of the policy. This was in part due to limited data availability.

group of firms that undertake research but do not claim the R&D TI. They compared the actions of those firms with the actions of those that do receive the R&D TI. They concluded that the additionality rate was between 0.8 and 1.9.

There are two points worth considering about the experiment conducted by Thompson and Skali, as well as in similar econometric exercises, that stem from the fact that there is not a measure of R&D independent from that reported by firms. Each of these points tends to indicate that econometrically estimated additionality rates may be overstated:

- There may be a systematic financial incentive for firms that receive the R&D TI to overstate their R&D expenditure in order to maximise their tax offset. Firms that do not receive the R&D TI do not have this incentive. Because measured R&D is reported R&D, there is a potential for the difference in R&D expenditure between the two groups to be systematically biased. This bias will tend to overstate the estimated additionality rate.
- We would expect there to be some indirect interactions between recipient firms and R&D conducted by non-recipient firms. Firms that receive the R&D TI are expected to increase their demand for R&D, increasing the price of R&D inputs (such as wages of qualified researchers). This will have a dampening effect on R&D conducted by non-recipient firms. These indirect interactions between firms that receive the R&D TI and those that do not mean that the two groups are not entirely independent. With this effect, the difference in R&D conducted by the two groups is increased, and the estimated additionality rate would be overstated.

Additionality under the R&D Tax Concession

In previous work evaluating the R&D Tax Concession, the CIE (2003) estimated the additionality rate using six different approaches with varying levels of complexity. The estimated additionality rates, for the five methods that resulted in a point estimate, are shown in Table 3.13.

Using these results and the literature, the CIE preferred an additionality rate in the range of 0.5 to 0.9 with a mid-point estimate of 0.7.

Table 3.13 Estimated additionality rates

Methodology	Estimated additionality — average	Estimated additionality — high R&D	Estimated additionality — medium R&D	Estimated additionality — small R&D
Direct method	2.06	1.62	2.26	2.43
Historical method	0.91	0.91	0.92	0.81
Changed incentive method	0.57	0.54	0.79	0.76
Simple model	0.67	0.68	0.56	0.59
Economic R&D model	0.69	0.71	0.55	0.62

Source: CIE (2003).

Spillovers

Defining spillovers

Different authors define spillovers in different ways. In this report, we define spillovers as any benefit realised as a result of R&D undertaken by another party. Spillovers encompass any benefits that are gained without paying for the R&D (although benefiting from spillovers might not be costless).

The PC (2007) identified three major avenues by which spillovers may arise:

- high-quality human-capital development
- development of basic knowledge capabilities
- diffusion of new ideas among firms and others.

In the particular case of R&D conducted by businesses, businesses develop tangible goods and services that can be emulated by competitors, and train employees who are able to move and take ideas with them. Firms must often make investments in order to gain the benefits of others' commercially useful knowledge.

Pecuniary spillovers that can be observed in market interactions through lower prices or improved quality of goods and services are sometimes referred to as 'rent spillovers' (Hall et al. 2009). They arise when a firm or customer purchases R&D-incorporating goods or services but the prices do not fully reflect their user value due to imperfect price discrimination. This is more likely in competitive markets, as firms have less ability to appropriate the benefits of their R&D. These spillovers are also sometimes referred to as 'flow-on' effects.

Knowledge spillovers are those that do not flow through market mechanisms. They are generated where the knowledge generated by one firm's R&D is useful to another firm, either in conducting further research or in other activities. This spillover occurs because of the public good nature of knowledge, and particularly the difficulty in excluding people from accessing knowledge generated by others. Knowledge spillovers are non-pecuniary benefits and differ from technology transfer where a firm purchases knowledge.

Despite the fact that knowledge has public good aspects, it is nevertheless costly for other firms to absorb and use it even if the knowledge is free. The costs involved in absorbing 'spillover knowledge' are one factor determining the net dollar value of spillovers.

However, PC (2007) pointed out that apparent spillovers might not be true spillovers (or be as significant as they initially seem):

- There are many examples of firms developing inter-firm networks to share knowledge and internalise spillovers. In these cases, the appropriate public policy is to reduce the transaction costs in forming these cooperative arrangements, from which R&D will flow and be shared, rather than supporting R&D.
- The spread of knowledge through the movement of people is often touted as a form of spillover. However, some argue (see, for example, Møen 2001, cited in PC 2007)

that the acquiring firm pays for this knowledge through the wages paid for the employee carrying the knowledge. Despite this, there may still be some residual spillovers after accounting for this type of internalisation.

- Firms undertake other activities to internalise the returns from their R&D. This may include the production and sale of products and activities associated with the researched product where greater returns can be captured.

Spillovers measured in the literature are generally market values. However, some spillovers that do not have market values would be expected (for example, spillovers from research that result in benefits to the Australian environment or the health of the Australian population).

Increases in jobs and exports in themselves are not necessarily spillovers. While they are often quoted as being benefits of innovation or research, in economic analysis an increase in jobs generally reflects an increase in labour costs rather than a benefit. Greater exports also have the potential to result in costs to the Australian economy through exchange rate effects. These factors need to be considered as part of a general equilibrium analysis rather than being counted as direct benefits.

International, high-level assessment of spillovers

Baumol (2010) estimated the likely spillover rate (that is, the proportion of the benefits from innovation that are not captured by the innovator) using data on productivity, investment in innovation and returns on investment in the US. He found that the spillover rate was likely to be around 90%. However, he did not attempt to directly identify the drivers of productivity; nor did he try to isolate the returns to research conducted within the US. These further steps were examined by the PC (2007).

Productivity Commission estimate of spillovers

After comprehensive analysis and a rigorous review of the literature, the PC (2007) concluded that it was not possible to obtain accurate estimates of the social return on business R&D in Australia, due to both measurement and methodological issues.

Despite this finding, the PC did draw some conclusions from the available evidence. It is expected that business R&D would have smaller spillovers than publicly conducted R&D. The strongest case for public support for business R&D is for R&D that:

- is novel
- is of the type of R&D that is likely to respond to government support
- generates knowledge that spills over cheaply to others or triggers innovation by rivals
- has many potential domestic beneficiaries (for example, generic technologies) or many potential users.

The reviewed literature found spillover rates of return¹⁶ for market-oriented R&D¹⁷ from 0% up to 150%, with an average of 100%. However, the PC dismissed the face value results of those studies due to concerns about misspecification and non-independence.

Using time-series econometric models, the PC estimated the spillover rate to range from 86% to 183%. Shanks and Zheng (2006), a companion study to PC (2007), found spillover rates of 0% to 85%. While the results are imprecise, the analysis shows that spillovers are positive.

Using a constrained semi-parametric method, the PC estimated R&D stimulated by public support to have a spillover rate of return of around 65% (or from 35% to 100%). This is equivalent to an elasticity of multifactor productivity for R&D of around 0.02. The semi-parametric approach has the advantage of imposing commonsense prior expectations of the estimated range of the effects of variables other than R&D on productivity. This helps to avoid some of the risks of standard econometric analysis and appears to be the approach preferred by the PC.

Recent research on spillovers: using an intangible capital approach

Recent research in the UK (see particularly Haskel and Wallis 2010) uses an ‘intangible capital’ approach to create both a new measure of productivity (total factor productivity or multifactor productivity) and a new range of measures of a set of investments (in knowledge) that determine productivity.

The use of intangible capital as a measure allows standard measures of total factor productivity growth to be adjusted for the capitalisation of knowledge assets while at the same time allowing for potential spillovers from intangible assets other than R&D. The latter feature allows, in effect, a greater control for the effects of R&D in particular. Table 3.14 summarises the typical elements of intangible capital.

¹⁶ The rate of return refers to the additional output (or GDP) derived from an increase in R&D stocks.

¹⁷ Market-oriented R&D is R&D that is targeted at increasing market sector GDP. This includes business R&D and some (but not all) R&D by higher education and public sector research agencies (see Table G.1 in Appendix G of PC 2007).

Table 3.14 Intangible capital

Main item	Components
Computerised information	Computer software
	Computer databases
Innovative property	Scientific R&D (includes social sciences)
	Mineral exploration
	Copyright and licence costs
	Other product development, design and research
Economic competencies	Brand equity (includes advertising and market research)
	Firm-specific human capital
	Organisational capital (internally generated and purchased)

Source: Elnasri and Fox (2014).

The Haskel and Wallis results were startling in that they failed to find any evidence of spillovers from business expenditure on intangible capital. In contrast, there was evidence of substantive spillovers from spending by research councils. Haskel and Wallis recommended a move away from tax incentive programmes for business.

In Australia, Elnasri and Fox (2014) applied the same broad methodology to Australian data. Their results were equally startling:

- While they found evidence of spillovers from business investment in intangible capital, they found no evidence of spillovers from R&D funded by the R&D Tax Concession.
- The evidence of overall spillovers depended on the model specification, but they arose from each of software, innovative property and economic competencies:
 - When the three sources were all included in one model, the most significant spillovers came from software and economic competencies.
 - In contrast, a range of model specifications found no evidence of positive spillovers from business R&D generated through public support. In general, the estimated coefficients on these variables were not statistically significant, and had a negative sign. One model had a significant coefficient, but this was negative.

These results are a challenge to the notion that incremental R&D induced by the R&D TI will necessarily have positive spillovers.

Of course, the results from both of these studies are subject to the usual limitations of time-series econometrics.

4 Consultations

Those consulted as part of this review were generally favourable towards the R&D TI but highlighted the need for policy certainty for the programme to be effective. Anecdotal evidence suggested that small start-ups, particularly in research-focused areas (such as biotech), had the greatest additionality rates.

Who was consulted

The consultations conducted during this review included formal consultations, mostly with tax agents and industry groups, as well as ad hoc conversations and interactions with survey participants. Key policy stakeholders were also consulted. A full list of the groups invited to formal meetings is in Appendix D.

While the consultations were extensive, a clear gap in the consultation was in discussions with the R&D decision-makers within companies. The perception that the R&D TI is a tax measure resulted in tax consultants and tax/finance managers, rather than R&D managers or decision-makers, being tasked with completing the survey and interacting with the CIE.

Formal meetings

A series of specific meetings was arranged for peak body groups and R&D TI consultants. Many of these were group meetings where a number of different organisations were present. Individual meetings were also conducted with some of the major consultants (Deloitte, KPMG, PwC, Ernst & Young and Michael Johnson and Associates), some industry peak bodies (Minerals Council of Australia, Australian Industry Group, AusBiotech, Universities Australia, Federal Chamber of Automotive Industries) and the CSIRO.

In these meetings, the stakeholders provided their views on how they (or their clients and members) perceived the programme, areas where they thought the programme could be improved and some limited information about how the R&D TI is used by firms. The formal consultations were also used as an opportunity for the review team to provide information to the stakeholders about the review process and the survey being conducted.

The key findings from the consultations are summarised here and described in more detail in Appendix D.

Informal discussions

Informal interactions with firms completing the survey also provided significant insights into how the R&D TI is used. There was some degree of interaction with around 100 of the survey participants, and more in-depth conversations with 6–10 of them. These conversations were either in the context of answering to specific questions arising from the survey, or more wide-ranging discussions held in place of completing the survey.

Summary of stakeholder feedback

This section summarises the views and opinions that were garnered through the consultations. Our selection of comments does not reflect a view on whether or not the comments were valid or convincing.

Overall, stakeholders were pleased with the programme and were clearly in favour of continuing and improving it. One stakeholder said, ‘The R&D Tax Incentive is the jewel in the crown of innovation policy; we need to protect it’. The R&D TI is seen as a **fundamental part of Australia’s R&D policy**.

The transition to the R&D TI from the R&D Tax Concession was considered to have been **more successful than expected**, particularly for small businesses and those in loss. Noted strengths of the programme include:

- The self-assessment process is quick and has low administrative costs.
- The improvements to the treatment of foreign-owned companies and overseas findings are welcome. The overseas findings help medium companies stay in Australia.
- Unlike under a grant arrangement, firms have to commit to spending in advance, which ensures a degree of personal investment and commitment to the projects.
- Every start-up (known to a particular participant) has at some point relied on the R&D TI—it increases the chance of survival for firms.

One firm (conducting medical research) gave this feedback on the programme:

Overall we believe that the program is effective and pragmatic. We see different approaches in different countries and often the programs directly or indirectly motivate companies to digress from their own project. Or they spend more time on submitting proposals for calls and grants than keeping up the momentum on the development that is on the critical path. The R&D Tax Incentive supports what the company is set up for and helps bear the cost of that.

A consistent message throughout the consultation process was the **need for certainty**:

- Certainty has two dimensions—certainty that a business or activity is eligible for the incentive and certainty about the amount of the benefit it would receive.
- Constant policy changes (or the prospect of changes) causes instability, which causes harm to the innovation system.
- Where there is uncertainty about the programme, firms do not incorporate the incentive into their decision-making process and therefore the programme will clearly not be maximising the potential additionality. Rather, the incentive is collected by firms as an after-the-fact bonus.

- Investment decisions in some cases have time horizons of up to 15–20 years, and certainty is required for the R&D TI to be considered in decision-making.
- The retrospective nature of the proposed rate reduction measure (to the previous financial year) is a concern.
- Changing programme settings with each change of government, and even each change of leader, prevented the programme from being used as intended and was setting it up to not deliver as expected or to its potential.

Many stakeholders expressed **concern about the review process**:

- There was a consistent comment on review and submission fatigue, to the point where some stakeholders declined to participate in the process because they felt it was pointless.
- A related concern was that all the various reviews and policy activities in this space were not being coordinated.
- Some stakeholders felt that the programme had not been running long enough for a review to be worthwhile.
- Reviewing the programme instils further uncertainty in the business community and gives a feeling that the programme is under constant threat of being revoked.

Generally, stakeholders were **satisfied with the administration of the programme**. The only notable area for improvement was in the provision of more case study-type examples of eligible activities. Those examples would serve two purposes: to provide greater clarity and certainty to firms when they are registering for the incentive; and to ensure greater consistency in AusIndustry determinations.

The consultations found **limited evidence of additionality**. The strongest evidence of additionality came from small start-up firms in which most of the activity is R&D and which do as much R&D as they can afford. In these cases, it appears that there are very high rates of additionality, as the firms re-invest all of the refunded tax offset into R&D. Other firms suggested that they may conduct R&D faster with the R&D TI than otherwise.

Many of the peak bodies, consultants and large firms discussed the role of the R&D TI in attracting R&D by multinational corporations to Australia. They advised that it is important to maintain or increase the incentive to compete for R&D with incentives in other countries. Australia's incentive was generally noted as being less attractive than schemes in other countries.

5 *Programme implementation, administration and use*

AusIndustry, the programme delivery division of the Department of Industry, Innovation and Science tasked with administering the R&D TI on behalf of Innovation Australia, has undertaken extensive activities to implement the R&D TI.

Ongoing administration of the programme uses a guidance-led approach and self-assessment processes. AusIndustry and the Australian Taxation Office conduct compliance assurance activities using a risk management approach to maintain the integrity of the programme.

Internal evaluations of the administration of the programme and feedback from stakeholders through consultation reflect favourably on AusIndustry.

Responsibility for administration of the R&D Tax Incentive

The R&D TI is administered jointly by AusIndustry (on behalf of Innovation Australia) and the Australian Taxation Office (ATO).

Innovation Australia is a board established under the *Industry Research and Development Act 1986* to administer a range of Australian Government innovation and venture capital programmes. Membership of Innovation Australia is drawn primarily from the private sector. Members' qualifications and experience cover a wide range of commercial and technical areas in various industries.

Innovation Australia has the legislated responsibility for registering R&D activities, registering Research Service Providers and ensuring programme integrity. Innovation Australia also makes decisions (in the form of 'findings') about the eligibility of R&D activities and company registrations.

AusIndustry, the specialist programme delivery division within the Department of Industry, Innovation and Science, delivers programmes to support the Australian business community, including the R&D TI. Innovation Australia has delegated certain functions and decision-making powers to AusIndustry to enable it to perform this function. Under those delegations, AusIndustry administers the process for registering R&D activities, registering Research Service Providers, and managing programme integrity through education and compliance activities.

AusIndustry informs the business community about the R&D TI's benefits and eligibility requirements through guidance material and its customer service manager network in

offices across Australia. AusIndustry guidance material is available from business.gov.au.

The ATO, the Australian Government's principal revenue collection agency, determines whether expenditure relating to, or assets used for, eligible R&D activities are eligible for the R&D TI. The ATO also provides advice (including private binding rulings) and undertakes compliance activities as part of its administration of the R&D TI.

Implementation of the R&D Tax Incentive

In the 2009–10 Budget, the government announced that it would replace the R&D Tax Concession with a new streamlined tax incentive. The government issued a consultation paper titled *The new research and development tax incentive* in September 2009. Exposure drafts of the Tax Laws Amendment (Research and Development) Bill 2010 to establish the programme were released in December 2009 and March 2010. The legislation became an Act of Parliament when it received royal assent on 8 September 2011 and applied to income years that commenced on or after 1 July 2011.

At the time of its introduction, the R&D TI was the biggest reform to business innovation support for more than a decade. The programme provides more generous rates of assistance in the form of a more attractive tax offset, compared with a deduction under the R&D Tax Concession. The programme also includes a tighter definition of R&D activities, which is intended to be a more targeted incentive for companies to invest in R&D and to deliver value for money for taxpayers.

The introduction of the R&D TI was accompanied by an increase in the funding to administer the programme, which enabled a transformation in the approach to its administration. In the main, this has involved:

- the adoption of a guidance-led approach to the administration of the programme
- an enhanced array of guidance and education materials
- greater stakeholder engagement
- improved systems, operational processes and staff training
- the implementation of a connected set of escalating compliance assurance activities.

Activities to implement the R&D Tax Incentive

The implementation of the R&D TI required a diverse range of activities to ensure that companies and their tax and accounting advisers were aware of the new programme and (in the case of companies that had accessed the R&D Tax Concession) understood the changes that had been made.

According to AusIndustry, feedback from a variety of sources, including individual firms and industry associations, indicated that AusIndustry and the ATO were successful in raising awareness of the new programme. There was a high level of comprehension among the business community of the new programme and its benefits, and strong

engagement with the administrators regarding guidance and education on the programme's eligibility requirements, application process and compliance obligations.

AusIndustry provided this data on specific indicators to demonstrate the successful implementation of the new programme:

- 8,700 people attended more than 820 workshops and briefings conducted by AusIndustry and the ATO as part of the implementation and early commencement of the programme (as at April 2014).
- 1,100 individual company education visits were conducted (as at November 2014).
- More than 8,700 calls to the AusIndustry contact centre were made and 600 'live chats' were conducted online (as at April 2014).
- Over 1 million visits were made to the AusIndustry R&D TI website (August 2012 – April 2014)
- Over 11,000 people subscribed to the quarterly R&D TI eBulletin (as at April 2014).
- 170,000 printed guidance products were distributed nationwide (July 2011 to June 2014)
- 100% of registrations are now submitted using the online application form (as at April 2014).

Since 2014, AusIndustry and the ATO have continued to conduct workshops and briefings and have released additional guidance products.

Monitoring the implementation of the R&D Tax Incentive

The R&D Tax Incentive Advisory Committee (TIAC) was established on 3 October 2011 as a committee of Innovation Australia with the specific role of monitoring the implementation and operation of the R&D TI. The decision to establish the committee followed a recommendation of the Senate Economics Legislation Committee report of 15 June 2010 on the draft legislation for the introduction of the R&D TI.

The TIAC was charged with monitoring the implementation and operation of the R&D TI, with particular focus on:

- transition/implementation outcomes and issues
- assessing progress against the policy intent of the programme
- identifying any unforeseen consequences or unintended and significant compliance costs.

The seven TIAC members were appointed by the then Minister for Industry in accordance with the *Industry Research and Development Act 1986* on the basis of their skills and experience and were drawn from a wide range of backgrounds across industry and key stakeholder groups. The committee met on five occasions.

At its meetings, the TIAC considered a range of reports provided by AusIndustry and the ATO relating to the programme's implementation. It also considered feedback provided directly to committee members and through the programme's communication channels (for example, its website, email and AusIndustry customer service network) on how the

programme was being implemented and on its operation. The TIAC reported to Innovation Australia after each of its meetings. While it noted that limited information was available to form views on whether the programme was meeting the policy intent, given the early stages of the programme, no significant issues were identified.

The TIAC having completed its work, the then Minister for Industry formally disbanded the committee with effect from 31 March 2014. Continued monitoring of the R&D TI is undertaken by the R&D Incentives Committee of Innovation Australia.

As noted in Chapter 4, feedback from stakeholders in consultations for this review indicated that the transition from the R&D Tax Concession to the R&D TI was successful.

Administration and delivery of the R&D Tax Incentive

Guidance-led approach to administration

A guidance-led approach has been adopted for the administration of the R&D TI. This approach seeks to enable and empower companies to effectively self-assess their eligibility under the programme. AusIndustry and the ATO state that they aim to provide participants with the clarity and certainty they require to enable easy and efficient access to the benefits they are entitled to under the programme, but understand the need for participants to maintain high levels of compliance with programme requirements.

This approach to integrity assurance is based on:

- ongoing consultation and engagement with participants
- a guidance focus to allow easy access to the programme
- promoting good governance and record keeping
- delivering robust compliance assurance activities
- minimising compliance costs for participants over the longer term
- delivering services in a timely and consistent manner.

Guidance and education products made available on include:

- the business.gov.au and ato.gov.au websites
- a guidance and information library with general programme guidance, a guide to interpretation, industry-sector guides, hypothetical examples, specific issues guidance, guides to the various findings under the programme, guides on compliance and integrity assurance, guidance for Research Service Providers, a variety of fact sheets and responses to frequently asked questions
- customer stories providing real-world examples of how the R&D TI has assisted companies across Australia to access opportunities, grow their business and remain competitive
- multimedia resources, such as podcasts and vodcasts

- information on the governance of the programme by programme administrators and the legislation, frameworks and agendas that they follow
- the online eBulletin, which is generally released quarterly to disseminate important programme information.

Compliance assurance activities

AusIndustry performs compliance assurance activities as an important aspect of the approach to programme integrity. It adopts a risk management approach and assesses programme participants against a range of filters to identify possible indicators of risk. Generally, the indicators are based on:

- the scale and complexity of the R&D activities being registered
- the level of claimed expenditure
- industry and sectoral intelligence
- prior registration information and trends
- compliance history
- financial ratios.

AusIndustry performs a number of different risk review activities designed to evaluate and resolve identified risks at the earliest possible opportunity while minimising the impact and costs to programme participants. This approach draws upon intelligence shared between AusIndustry and the ATO.

AusIndustry risk review activities are designed to deal with the potential risk of noncompliance at the pre-registration and post-registration stages:

- *Pre-registration review*: designed to assess risk in cases where AusIndustry's monitoring processes have identified acute risks of noncompliance in an application for registration (before registration has been approved).
- *Registration review*: evaluates the information provided by a company in its application for registration; takes place after the registration has been approved by AusIndustry and is designed to identify potential compliance risks.
- *Desk review*: involves a deeper analysis of registered activities and is generally undertaken in the event that outstanding compliance risk remains following a registration review.
- *Activity review*: undertaken in the event that a desk review does not satisfactorily resolve identified compliance risks; designed to give companies an opportunity to clarify potential risk issues in relation to specific registered activities.
- *Large business innovation review*: designed for large businesses accessing the programme; AusIndustry recognises that the programme's largest participants often undertake large-scale, complex and diverse R&D work; applies only to certain types of registration and is not relevant to SMEs.

In addition to, or as a result of, reviews, AusIndustry issues findings about the eligibility of R&D activities:

- *Advance findings:* provide companies with certainty about whether their R&D is eligible before they incur the costs of conducting the activities or, if they have already conducted the activities, before they register the activities and include the costs in their company tax returns.
- *Overseas findings:* provide certainty about whether costs associated with overseas R&D activities are eligible. Programme participants must obtain an overseas finding, prior to registration, if they wish to claim expenditure associated with overseas activities under the R&D TI.
- *Post-registration findings:* An important element of the programme's integrity rests with the ability of Innovation Australia to determine the eligibility of activities in specific circumstances. Innovation Australia can examine a company's activities to make a finding about their eligibility; these findings are issued following an activity review.
- *Findings about an application for registration:* In certain circumstances, Innovation Australia may choose to make a finding about the eligibility of activities described in an application for registration. This finding is made at the time a company seeks to register the activities. Only Innovation Australia may initiate this particular type of finding. The finding is prompted by the outcome of a pre-registration review that finds an acute risk of noncompliance.
- *Core technology findings:* Companies may seek a finding about technology that they have purchased for their R&D activities. In this finding, Innovation Australia determines whether the technology is or is not 'core technology', and therefore whether the firm is able to claim the R&D TI for that expenditure.

Information on the compliance activities undertaken by AusIndustry in 2013–14 and the estimated time required for each activity are summarised in Table 5.1.

Table 5.1 AusIndustry compliance activities, 2013–14

Activities	Number of activities	Estimated time per activity (days)	Total time per activity type (days)
Education appraisals	324	0.5	162
Education visits	149	1.25	186.25
Workshop: customer education	565	0.5	282.5
Pre-registration reviews	76	1	76
Registration reviews	594	1.25	745
Large business innovation reviews	2	15	30
Desk reviews	398	5	1,990
Activity reviews	176	7.5	1,320
Pre- and post-registration findings	45	10	450
Advance and overseas findings	225	15	3,375
Internal reviews	35	15	375
Litigation forensic audits	4	–	–
Total	–	–	8,991.75

Source: AusIndustry 2015, *R&D Tax Incentive Workload Portfolio 2015/16*.

The ATO also undertakes a range of compliance activities, focusing primarily on the expenditure and the behaviour of R&D consultants and tax agents. The ATO takes a risk approach similar to AusIndustry's, focusing on identified risk areas while monitoring the remaining population.

The ATO's compliance activities take many forms, including:

- audit activity on an individual company claiming R&D
- education and guidance
- investigation of identified risks within a population
- specific action against R&D consultants and tax agents, who are both required to be registered as tax agents with the Tax Practitioners Board.

The ATO focuses on the risks associated with the expenditure of the R&D claim, which includes general operational expense claims versus R&D expenditure, overclaiming, lack of substantiation, the nexus of claim to activity, and payments to associates. The ATO may also identify potential issues with the R&D activities. Where this issue arises, the ATO liaises with AusIndustry as part of the co-administration of the programme.

Specific compliance activities conducted by the ATO are as follows:

- *High risk refunds:* Tax refunds associated with an R&D claim are subject to a number of specific R&D risk filters before the refund is issued. If a refund is identified as being 'at risk', the refund is taken offline and reviewed. If warranted, the refund is escalated to a review product, which may be escalated to an audit product. The

refund may be released at any stage of the process if the compliance officer is satisfied that the refund should be released.

- *Reviews selected as normal tax return risk work:* Tax returns are routinely selected for review activities that may be escalated to audit activities because the return may have triggered certain ATO risks. A tax return may trigger a number of risks, which may include a claim for R&D.
- *Targeted risk work:* This work focuses on a specific risk that has been identified, which may be an industry, specific types of claims or a geographical location.
- *Tax agents and promoters:* Returns lodged by specific tax agents are reviewed and audited where a risk has been identified with a number of the returns. The compliance activity will also involve specific actions against the tax agent. This includes R&D TI consultants, as there is a legislative requirement that they be registered tax agents.
- *Fraudulent claims:* Where fraudulent claims are identified, the ATO will use specialist staff to investigate, with a view to prosecuting the alleged offenders.
- *Schemes:* Where a group of taxpayers make similar R&D claims based on the advice of a promoter, the ATO will take action against the promoter of the scheme. The ATO may issue a 'taxpayer alert' notifying the public that the Commissioner has identified a potential scheme and to make the public aware that the ATO has concerns about the arrangement and is undertaking compliance work on it. The most recent taxpayer alert was developed jointly between the ATO and AusIndustry and issued as a co-branded taxpayer alert.
- *Joint activities with AusIndustry:* The ATO undertakes a number of joint risk projects and activities with AusIndustry, which include targeted activities such as joint large market reviews and industry-based activities.
- *Guidance:* The ATO publishes guidance material in the form of tax rulings and determinations and private binding rulings on R&D issues (including publicly available edited versions of private binding rulings). This material is issued in printed form and, more recently, in electronic form on the ATO website. The ATO and AusIndustry issue co-branded guidance providing clarity on R&D issues.
- *Education:* The ATO makes presentations to taxpayers, tax agents and professional associations on R&D risks and expenditure issues.

The ATO did not provide the review team with any further details on the outcomes of these compliance activities, but provided this statement:

In relation to the R&D Tax Incentive scheme a small percentage of companies try to claim refunds or other payments they are not entitled to, or deliberately and dishonestly break the law to avoid paying tax. The ATO uses a range of strategies that remove the opportunity for companies to intentionally break the law and avoid detection. The ATO has increased its ability to identify risks using sophisticated data analytics and intelligence, cooperating with our partner agency, AusIndustry.

By agreement with the department, compliance activities are not considered any further in this review and do not form part of the analysis undertaken.

Evaluation of AusIndustry's administration of the programme

AusIndustry commissions customer satisfaction surveys of the programmes that it administers to:

- establish and track performance against key customer satisfaction benchmarks
- provide accessible, statistically significant, quantitative measurements of overall customer satisfaction and satisfaction at the programme level
- gather qualitative feedback on areas of strength or concern and suggestions for service improvement
- assist it to target actions for customer service improvements.

According to AusIndustry, the 2014 round of the Cross-Programme Customer Satisfaction Survey found that customer ratings for most aspects of customer satisfaction were high, and included increases in satisfaction in a number of areas when compared with previous years.

Overall satisfaction with AusIndustry's service delivery increased to 93% (up from 85% in 2012) and was at its highest level since the survey commenced in 2003. R&D TI customers showed much higher overall satisfaction (94%) than the R&D Tax Concession customers surveyed in 2012 (84%). R&D TI and R&D Tax Concession customers accounted for 78% of the customer base covered by the survey.

In 2015, AusIndustry developed the R&D Tax Incentive Performance Management Framework to provide a structured, best-practice methodology to monitor (and inform evaluations of) the administrative efficiency and effectiveness of the delivery of the R&D TI over time. The framework:

- establishes and outlines clear indicators against which the administrative efficiency and effectiveness of programme delivery can be monitored over time
- identifies and organises information required to monitor AusIndustry's administrative efficiency and effectiveness in the delivery of the R&D TI over time
- enables AusIndustry to identify areas for future enhancement and continuous improvement in the administration and delivery of the R&D TI
- demonstrates the linkages between departmental inputs or resources and their impact on the administrative efficiency and effectiveness of programme delivery.

In developing the framework, four small-scale pilot evaluations were conducted on some key areas of programme delivery:

- the relevance and currency of the Integrity Assurance Framework
- the appropriateness of the advance and overseas findings processes
- the development of various sectoral guidance products
- the evolution of AusIndustry's relationship with its joint administrator, the ATO.

Based on the pilot evaluations, AusIndustry concluded that administrative processes had been implemented effectively and efficiently, and that the level of collaboration and cooperation between the two administrators had been enhanced over the past five years.

Supporting this finding, no significant concerns about the administration of the programme were raised through the consultations for this review. A minority of activity reviews were reported to be onerous and lengthy, and there appear to be some concerns about the consistency of the application of definitions among some AusIndustry staff.

Current use of the programme

By sector

Based on participant registrations for 2013–14, the industry that is registering the most R&D under the programme is manufacturing (32.1% of the R&D expenditure and 41.0% of the projects registered).¹⁸ The mining sector accounts for 17.3% of R&D expenditure registered under the programme but just 7.1% of the projects, indicating that the projects registered by mining companies are usually large. Other sectors accounting for large shares of R&D expenditure under the programme are professional, scientific and technical services (14.6%), financial and insurance services (11.1%) and information media and telecommunications (9.1%).

By research area

Most R&D expenditure claimed under the programme (51.3%) is registered as being related to engineering, and most of this is being conducted by large firms (in particular in the manufacturing and mining sectors). Research in information, computing and communication sciences accounts for 27.2% (mostly by the finance sector), and all other research areas each account for 5% or less.

Patents registered by participants

A comparison by the CIE of programme participants and those registered in the IP Australia patents, plant breeders' rights and design database indicates that less than 20% of patents are held by R&D TI applicants (based on Australian IP applicants identified by an ABN held in the AusIndustry R&D TI database).

¹⁸ The figures in this section were provided by the Department of Industry, Innovation and Science. The industry classifications are consistent with ANZSIC divisions.

6 Features of the R&D Tax Incentive

By using the tax system to deliver support to R&D investment, the R&D TI avoids the costs of establishing a separate administrative framework. However, by using the tax system, the benefits of the R&D TI may be diluted, for example by the treatment of tax credits. There is also evidence that firms consider the programme as a tax measure rather than an R&D policy, which may affect its impact on R&D decision-making.

The impact of the R&D TI in increasing researcher–industry collaboration is limited, and alternative policies may be more effective in overcoming barriers to further collaboration.

Using the tax regime to support R&D

The use of the tax system to deliver support to R&D investment has advantages and disadvantages. The key advantage is that it leverages off an existing administrative framework and thereby reduces some of the potential administrative costs of delivering a widespread financial incentive to firms. However, the tax system is a very blunt instrument with which to ensure either additionality or spillovers from research.

Some known drawbacks of using the tax system for delivering funding for private sector R&D have been noted:

- The tax incentive is applied ‘below the line’¹⁹ and therefore receives less managerial attention (which drives decision-making somewhat less) than ‘above the line’ revenue sources.
- There are limitations on the availability of data associated with taxation, and therefore less information available for evaluating the scheme.
- The R&D TI has implications for tax imputation credits, which in some circumstances erodes the benefits of the R&D TI to the firm.

Linking the incentive to the tax system can result in a separation of the scheme from the R&D investment-making process. This separation means that the R&D TI might not be considered in that process. This became very apparent through the consultations and survey:

- It was clear that many firms (particularly large firms) view the R&D TI as a tax measure more than as an R&D measure.

¹⁹ The R&D TI is entered into firms’ accounts below, or after, the calculation of operating profits, along with entries for other items such as tax and interest.

- Preference for the incentive to be made an ‘above the line’ revenue source indicates that the incentive is currently not being considered fully in some organisations.
- Staff completing the survey were often in the finance sections of companies.
- Finally, most firms use consultants (many of whom also complete the firm’s tax returns) to apply for the incentive. The consultants’ dual role re-affirms the view of the R&D TI as a tax measure. Because any matters regarding the programme were referred to the consultants, the R&D TI was clearly not visible to decision-makers, raising questions about the effect that the programme has on decisions.

Researcher–industry collaboration

Evidence of collaboration through the programme

The only direct instrument for encouraging researcher–industry collaboration within the R&D TI scheme is the Research Service Provider (RSP) programme. In 2015, the department commissioned a survey of RSPs to gain an understanding of the success of the programme from their perspective. Mirror questions about the RSP programme were also included in the survey of R&D TI recipients.

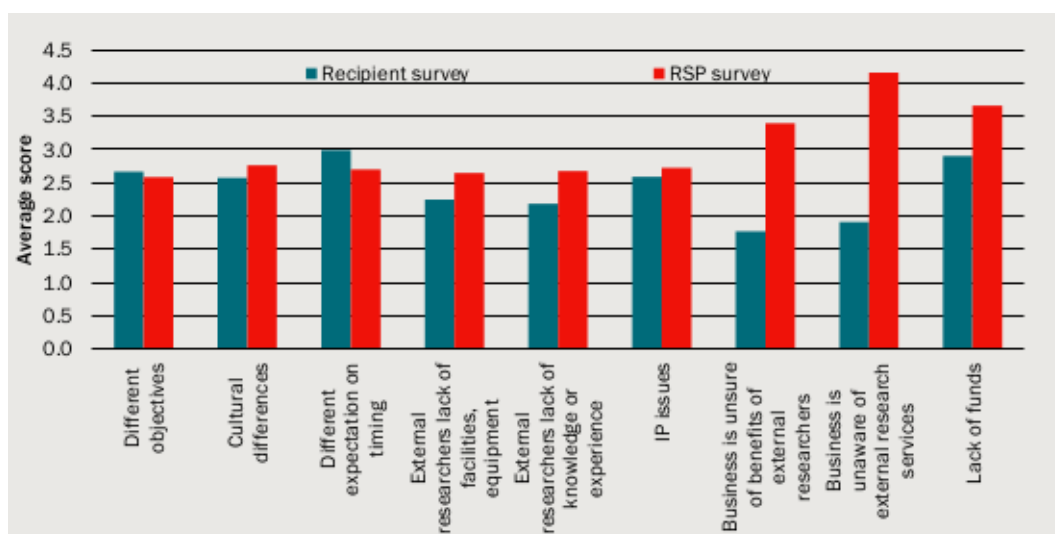
There are some evident differences in perceptions between the two sides of the collaboration.

From the recipient survey (weighted by R&D expenditure), around 25% of companies used an RSP. Looking only at sectors with sufficient responses, this share was highest in the mining sector, followed by manufacturing and agriculture. Scientific and technical services had a lower than average share (16%, compared with the average 25%). This contrasts slightly with the results from the RSP survey, in which agriculture was the most important industry sector, followed by mining and then scientific and technical services.

Both surveys broadly agreed that there were potential gains from further collaboration. To some extent, the businesses were more optimistic about this: in our survey, 64% considered that there are a few highly valuable opportunities for collaboration (compared with only 25% of RSPs in this category in the RSP survey).

Looking at perceptions of barriers to further collaboration, both surveys agreed that a major barrier was a lack of funds to finance external research activities. From the RSP survey, the other two most important barriers were lack of business knowledge about the benefits of collaboration or the services being offered. In contrast, those two factors ranked very low as constraints in the recipient survey. Rather, different expectations, cultural differences and different expectations on timing ranked highest as barriers. Those three factors in turn ranked very low in the RSP survey. Chart 6.1 shows these differences.

Chart 6.1 Importance of factors restricting collaboration with external researchers—RSP and recipient responses



Note: The CIE applied common scoring to the results of the RSP survey and the R&D TI survey using the scale: 1—not a barrier, 2—a small barrier and easily overcome, 3—significant barrier but can be readily overcome, 4—large barrier and not easily overcome, 5—large barrier and cost of overcoming outweighs the benefit.

Data sources: Based on data from Orima Research (2015) and R&D TI survey 2015.

Policy design for increasing collaboration

There is probably limited scope for the R&D TI to be used as an instrument to address the differences in perceptions and to therefore encourage more collaboration. For example, a ‘premium offset’ under the R&D TI for the use of RSPs may address some of the financing constraints (depending on the magnitude of the premium) but would not deal with the cultural, objective and timing constraints from the perspective of business. It would also not deal with the information issues from the perspective of the RSPs.

In order to increase the rate of collaboration between research and industry sectors, through the NISA, the government is:

- changing research block grant funding arrangements to better target collaborative research
- including non-academic and industry engagement measures for assessing university research performance
- establishing growth centres that will, among other things, improve engagement between researchers and industry
- opening a new round of applications for cooperative research centres
- improving the Research Council Linkage Projects programme
- expanding the Research Connections programme as the new Innovation Connections programme.

These initiatives more directly address the issue of collaboration and are likely to be more successful at increasing collaboration than minor adjustments to the R&D TI.

7 Survey results

The CIE surveyed R&D TI recipients to provide insights into the use of the incentive and which factors influence firms' R&D investment decisions. The survey questions were designed to allow for the estimation of additionality resulting from the incentive.

Overview of the survey

As part of this assessment of the R&D TI, the department commissioned a specific survey of the incentive registrants. The sample frame for the survey was sourced from the AusIndustry administrative database. The survey involved a census of large firms and a stratified random sample of SMEs.

Further details on the methodology used for the survey are in Appendix E.

For the survey and the subsequent analysis, SMEs were defined based on R&D expenditure. Large firms were defined as having annual R&D expenditure over \$2 million, and SMEs as having \$2 million or less. This differs from the treatment of firms under the R&D TI, which is based on turnover, but is consistent with wider statistical definitions of SMEs (see discussion in Box 7.1). Note also that, as described in this chapter, we also tested whether the definition of an SME changed key estimates of additionality and whether it was possible to optimise the definition for the purposes of the programme.

The survey questions (set out in Appendix F) were designed to allow for the estimation of additionality and spillovers resulting from the R&D TI.

Specifically, the survey outputs were used to develop an economic model of firms' responses to R&D incentives. The survey provided data on key performance measures for the programme, including:

- levels of investment in R&D and additional R&D activity in response to cost changes
- private returns on investment in R&D
- the nature and extent of spillovers
- the development of new products, processes and services
- sales of new products, processes and services, including exports
- collaborative arrangements entered into through projects, including alliances (domestic and foreign)
- the success rate and length of R&D projects
- the benefits of intellectual property (patents, licences, agreements and so on)
- firms' awareness of the programme

- the costs of registration for and claiming the incentive.

Box 7.1 Definition of SMEs

For the purposes of this report, we were interested in separately identifying small businesses to explore whether they exhibit R&D characteristics different from those of large businesses. The most relevant measure of the size of businesses for this purpose is R&D expenditure.

The accepted Australian statistical definition of an SME, and the definition used by the ABS,²⁰ define an SME as a firm with fewer than 200 employees. The level of R&D expenditure that most closely aligns with the statistical definition of an SME is R&D expenditure of \$2 million or less, and this is the definition that has been used throughout this report when distinguishing between small (SME) and large firms. Any firm that had registered annual R&D expenditure of more than \$2 million in any year between 2011–12 and 2014–15 was classified as large.

The application of the R&D TI policy differs based on a firm's level of turnover. Turnover is frequently used by the ATO to distinguish different sizes of firms. The turnover threshold used under the policy (\$20 million) does not correspond to the statistical definition of an SME. On average, a firm with 200 employees (the smallest firm that would be classified as large), has a turnover of around \$60 million).

The choice of definition of an SME in this report was driven by these factors:

- R&D expenditure is the most relevant metric for the policy being analysed.
- Data on R&D expenditure is available and reliable for the population and survey sample used in this report.
- R&D expenditure of \$2 million or less closely aligns with the statistically accepted definition of SMEs.

Key findings and results

Representativeness

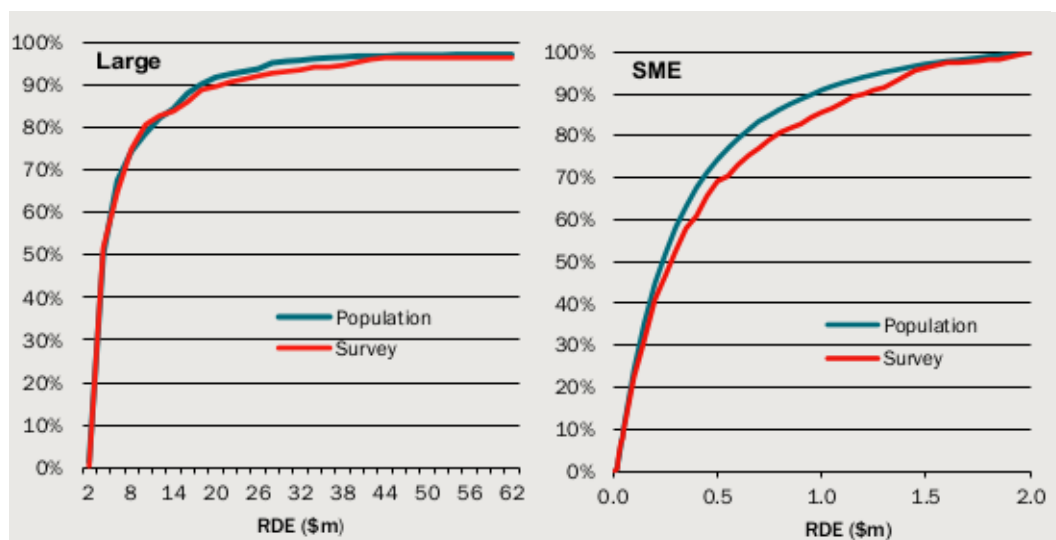
The survey received 785 completed responses, of which 335 were from large entities and 450 were from SMEs. The target response rate of 20% was achieved, with a slightly higher response rate for SMEs (20.4%).

In general, the respondents represented the population of entities registered for the R&D TI well. Chart 7.1 draws the cumulative frequency distribution of R&D expenditure by large firms and SMEs against the population distribution of R&D expenditure. The sample and population distributions are close, although SMEs were slightly less representative for entities with R&D expenditure of around \$1 million.

Chart 7.2 compares the sectoral distribution of R&D entities of survey respondents against the population, while Chart 7.3 compares the sectoral distribution of R&D expenditure. Sectors are defined by the Industry Division of Australia New Zealand Standard Industrial Classification (ANZSIC).

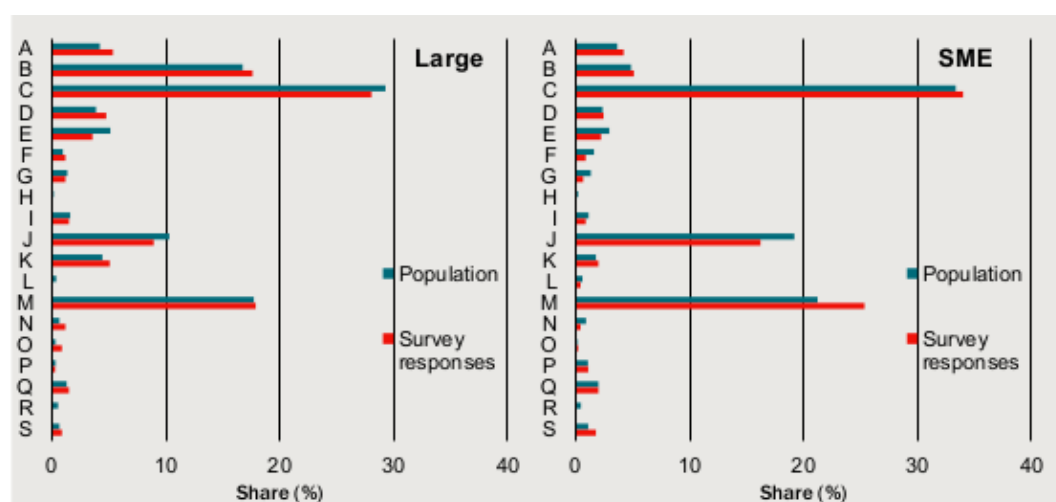
²⁰ See employment size ranges in ABS (2015).

Chart 7.1 Cumulative frequency distribution of R&D expenditure



Data source: R&D TI survey 2015.

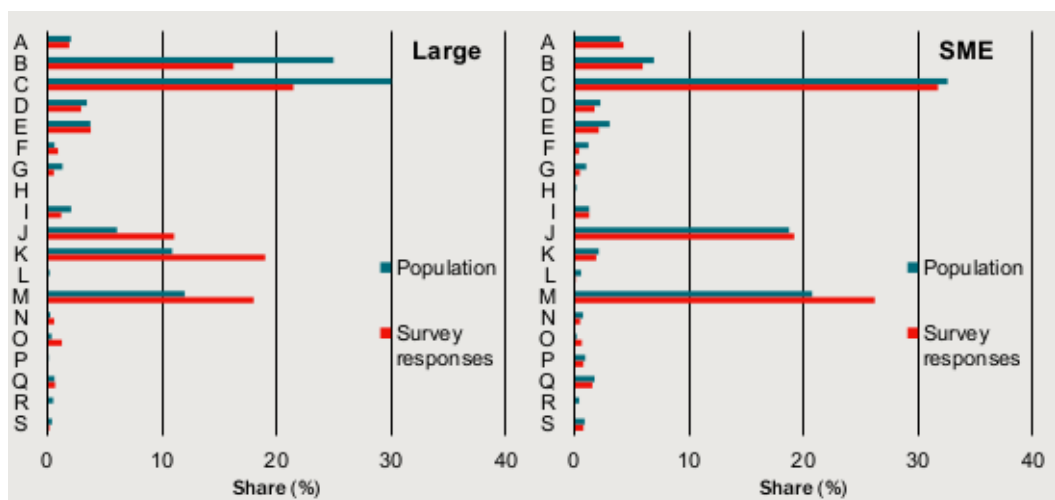
Chart 7.2 Sectoral distribution of R&D entities



Note: Vertical labels A through S represent industry divisions as defined by ANZSIC.

Data source: R&D TI survey 2015

Chart 7.3 Sectoral distribution of R&D expenditure



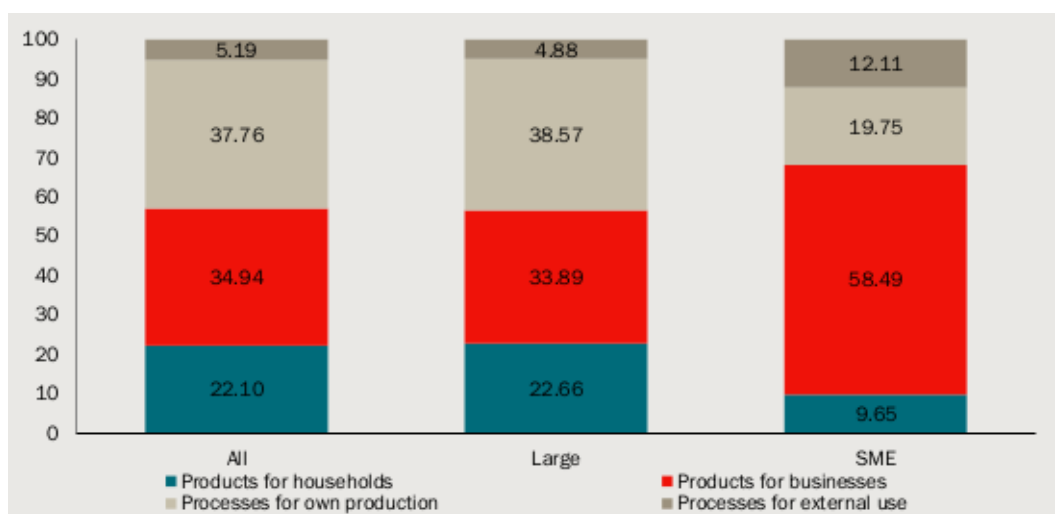
Note: Vertical labels A through S represent industry divisions as defined by ANZSIC.

Data source: R&D TI survey 2015.

Purpose of R&D expenditure

Question 9 of the survey asked firms the purpose of conducting R&D on average over the past five years. Overall, about 22% (the 95% confidence interval, or CI, is between 4.9% and 39.3%) of R&D expenditure is targeted to products or services sold to household consumers, about 35% (95% CI 23.9% to 46.0%) to products and services sold to businesses, 38% (95% CI 24.0% to 51.5%) to production processes for firms' own production, and 5% (95% CI 1.6% to 8.8%) to production processes for sale or licensing to other firms (Chart 7.4). About half of R&D spending is targeted to products and services for business and production processes for external use.

Chart 7.4 Purpose of R&D: products or processes for household or business customers



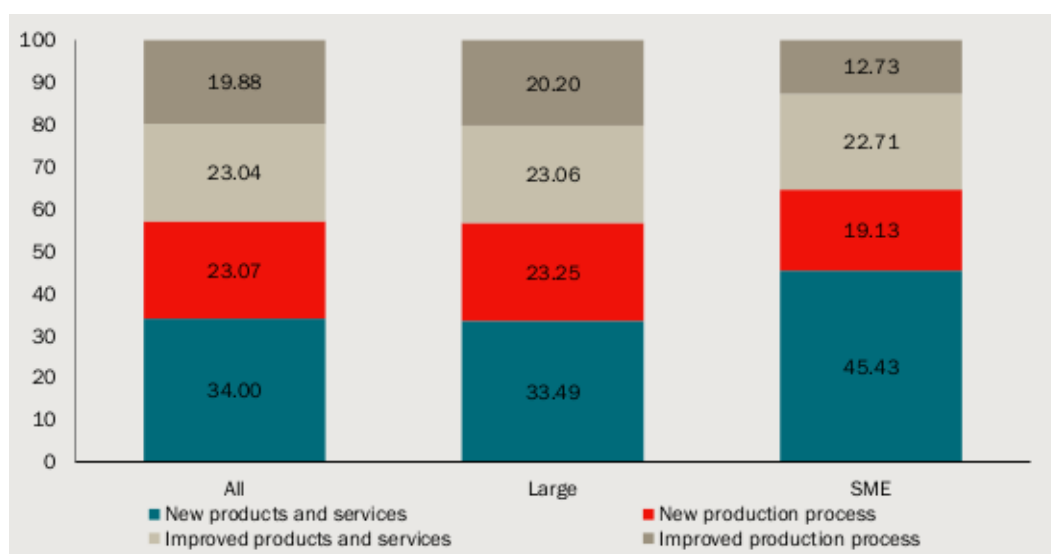
Note: Responses are weighted by R&D expenditure.

Data source: R&D TI survey 2015.

Large firms and SMEs had different patterns of R&D spending. SMEs had a higher proportion of R&D spending on products and services for business (58.5% by SMEs versus 33.9% by large firms) and on production processes for external use (12.1% versus 4.9%). These differences between SMEs and large firms were statistically significant: the p -value in both cases was less than 0.01 (in other words, the significance of difference is above 99%).

Chart 7.5 shows the proportion of R&D spending on developing new or improving existing products, services or production processes. Overall, 57% of R&D spending was for new products, services or production processes. SMEs spent 64.6% on new products, services or production processes, 8 percentage points higher than the proportion spent by large entities. However, the difference was not statistically different, with the p -value being 0.11. Within the overall category of new products, services and processes, large firms spent more on new production processes than SMEs, and SMEs spent more on new products and services than large entities (45.4% versus 33.5%; the difference is statistically significant with a p -value of less than 0.05).

Chart 7.5 Purpose of R&D: new or improved products or processes



Note: Weighted by R&D expenditure.

Data source: R&D TI survey 2015.

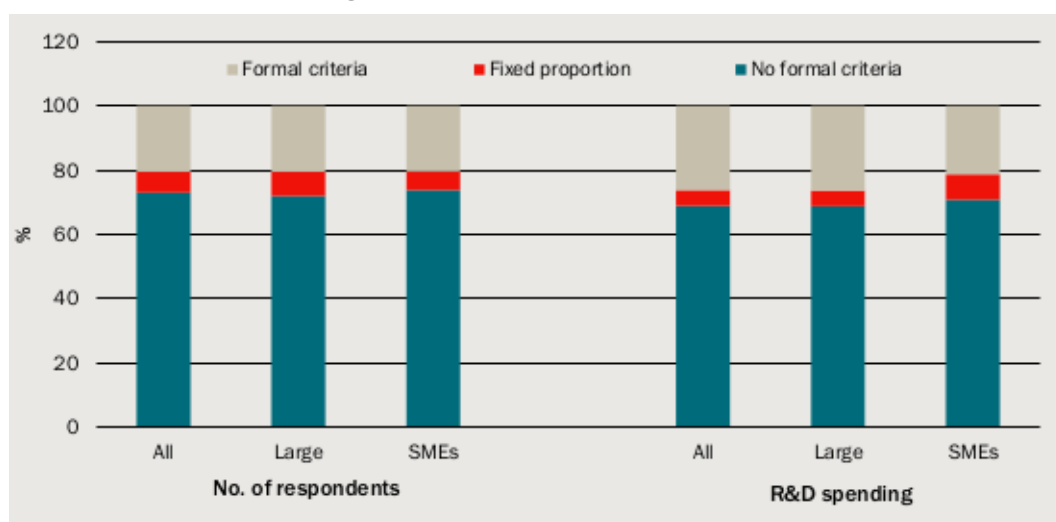
R&D decision-making

One of the most striking results from the survey related to the criteria for making R&D decisions (Question 10). Among the 785 respondents (Chart 7.6):

- 573, or 73% (accounting for 68.8% of total R&D expenditure; 95% CI 54.5% to 83.2%) did not have formal criteria
- 51, or 6.5% (representing 4.9% of total R&D expenditure; 95% CI 1.9% to 8.0%) spent a fixed proportion of revenue or turnover on R&D activities
- only 161, or 20.5% (accounting for 26.2% of R&D spending; 95% CI 12.2% to 40.3%) had formal decision criteria.

There was virtually no difference between the responses of large firms and SMEs in terms of the share of respondents. If weighted by R&D expenditure, however, SMEs had slightly lower proportions applying formal criteria than large entities (21.3% versus 26.5%; the difference was not statistically significant, with a p -value of 0.52).

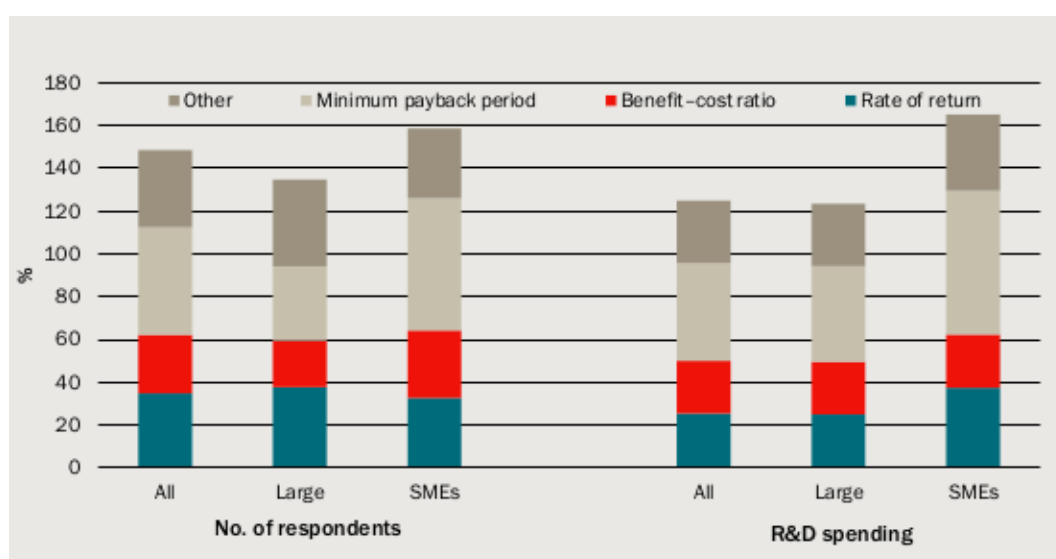
Chart 7.6 Criteria for deciding R&D



Data source: R&D TI survey 2015.

Among the 161 respondents applying formal decision criteria, 48 respondents applied more than one criterion. Half of the 161 respondents (accounting for 45.6% of R&D expenditure) used a minimum payback period as their R&D decision-making criterion. A hurdle rate of return was used by slightly more than one-third of the respondents (accounting for one-quarter of R&D expenditure), while a benefit-cost ratio was used by 27.3% (accounting for one-quarter of R&D expenditure) (Chart 7.7).

Chart 7.7 Criteria used for R&D decisions

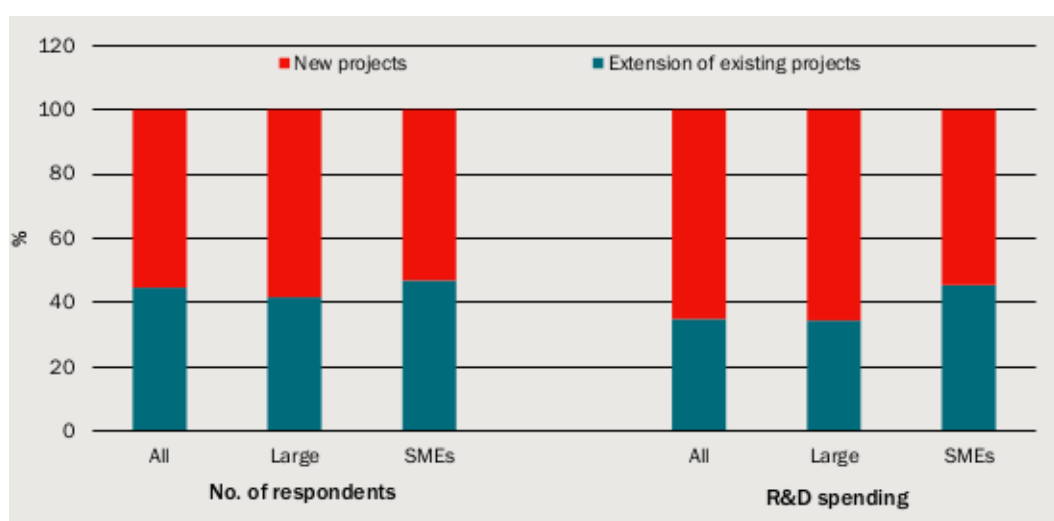


Note: The sum of shares is over 100 because some entities use more than one criterion.

Data source: R&D TI survey 2015.

If firms had more funds available for R&D, more would be spent on developing new projects rather than extending existing projects. As shown in Chart 7.8, slightly more than 55% (or 65% on average weighted by R&D expenditure; 95% CI 56.0% to 74.3%) of new funds would be spent on developing new projects. Large firms tended to spend more on new projects than SMEs (65.6% versus 54.6%), and the difference between large firms and SMEs was statistically significant (with a p -value of 0.036 for the difference).

Chart 7.8 How additional R&D funds would be used



Data source: R&D TI survey 2015.

Constraints on doing more R&D in Australia

Question 14 of the survey asked respondents to rate the importance of constraints on their level of R&D undertaken in Australia on a scale of 1 to 5 (from 1—not important to 5—extremely important. Table 7.9 shows the weighted average scores of constraining factors.

Resource constraints appeared to be the most important factor affecting R&D activity: 'limited availability of capital' was the top factor (average score of 3.19 for all respondents) excluding 'other'. SMEs appeared to have relatively stricter constraints on 'capital availability' than large entities (3.85 versus 3.16, with a p -value of 0.003 indicating a statistically significant difference).

Nevertheless, the listed constraints were generally rated as moderately important or less. Only 'capital availability' and 'other' (specified by only 14% of respondents) had an average score higher than 3 (moderately important).

Most of the other constraints specified by respondents emphasised the constraints already specified by the previous 15 items (for example, lack of funds or capital; lack of specialised technical personnel; low return due to the high risk and difficult nature of R&D questions; profitability; and market environment). Some pointed out other tax and government regulation issues, such as 'the plethora of tax and compliance' requirements (especially land tax and payroll tax), lack of uniform interpretation of national standards

across states, inadequate competition policy to protect small business and start-ups, and political uncertainty about tax reform and the R&D agenda. Some respondents also used this as an opportunity to suggest further reform to the R&D TI programme, such as changing the payment of benefits to up front, quarterly or even monthly, increasing the certainty of eligibility criteria, avoiding R&D tax offset effects on the ability to create franked dividends, reducing the complexity of the application process, and providing more support for commercialisation and overseas R&D.

Another observation from Table 7.9 is that SMEs faced more constraints than large entities. SMEs had higher ratings for most of the factors except for 'other', 'more profitable R&D overseas', 'low return from additional R&D' and 'limited availability of technical or specialist equipment'.

The final column in Table 7.9 provides the p -statistic for the difference between the large and SME results, as calculated from the survey data. A p -value below 0.1 indicates that the data shows a statistically significant difference between the responses of large firms and SMEs.

Table 7.9 Constraints on doing more R&D in Australia

Constraints	All	Large	SME	Significance of difference between large firms and SMEs
	Weighted average score (95% confidence interval)			p-value
Opportunity and motivation				
Limited technical opportunities for the R&D to target	1.51 (1.31–1.70)	1.50 (1.30–1.69)	1.77 (1.63–1.90)	0.024
Limited opportunity to market and sell new products, services or processes that may emerge from R&D	1.77 (1.51–2.04)	1.75 (1.48–2.02)	2.29 (2.13–2.45)	0.001
There are more profitable R&D opportunities overseas	1.80 (1.47–2.12)	1.80 (1.46–2.14)	1.69 (1.54–1.83)	0.530
R&D too risky to undertake in Australia	1.74 (1.43–2.05)	1.73 (1.41–2.06)	1.84 (1.70–1.98)	0.541
Too hard to keep the returns from R&D investment	1.94 (1.62–2.26)	1.93 (1.59–2.26)	2.28 (2.12–2.44)	0.063
Low return from additional R&D	2.40 (1.94–2.85)	2.40 (1.93–2.87)	2.30 (2.17–2.44)	0.698
Resource availability				
Limited availability of capital	3.19 (2.78–3.60)	3.16 (2.74–3.59)	3.85 (3.71–3.99)	0.003
Limited availability of skilled technical workers	2.42 (2.20–2.64)	2.41 (2.19–2.64)	2.54 (2.38–2.70)	0.368
Limited availability of appropriate research collaborators	1.97 (1.73–2.22)	1.96 (1.71–2.22)	2.21 (2.04–2.37)	0.106
Limited availability of technical or specialist equipment	1.98 (1.79–2.17)	1.98 (1.78–2.17)	1.96 (1.80–2.11)	0.869
Government constraints				
Company tax rate too high	2.38 (2.03–2.73)	2.36 (1.99–2.72)	2.83 (2.66–3.00)	0.021
Regulations restrict ability to undertake R&D	1.72 (1.36–2.08)	1.70 (1.33–2.08)	2.11 (1.94–2.28)	0.055
Labour market regulations make it hard to employ workers for R&D	1.86 (1.52–2.21)	1.84 (1.48–2.20)	2.31 (2.14–2.48)	0.022
Cost of obtaining patents or other form of IP	1.87 (1.57–2.17)	1.83 (1.52–2.14)	2.74 (2.56–2.92)	0.000
Inadequate protection of IP	1.92 (1.56–2.27)	1.89 (1.52–2.25)	2.58 (2.42–2.74)	0.001
Other ^a	3.91 (3.19–4.62)	3.95 (3.19–4.71)	3.37 (2.78–3.97)	0.246

^a Only 14% of respondents specified a factor not in the list.

Note: R&D expenditure weighted average score of importance: 1—not important, 2—somewhat important, 3—moderately important, 4—very important, 5—extremely important.

Source: R&D TI survey 2015.

R&D inputs

Overall, skilled labour was the dominant R&D cost item, accounting for more than half of total R&D expenditure, followed by contracted-out R&D (12.1%) and rent, buildings, plant and machinery (11%) (Table 7.10).

There were some interesting, albeit small, differences in R&D cost structures between large firms and SMEs. Large entities spent more on contracted-out R&D than SMEs (12.2% versus 9.6%; the difference was not statistically significant, with a *p*-value of 0.47), while SMEs spent more on collaborative R&D projects (4.5% versus 2.7%; the difference was not statistically significant). A reason for this may be that for large R&D projects it is easier to identify research components that are suitable for contracting out.

SMEs spent proportionally more on specialised technical or laboratory equipment than large entities (4.8% versus 2.4%, with a *p*-value of 0.008). This is probably due to three factors. First, by definition, R&D conducted by SMEs is smaller in scale; their purchases of the same equipment would cost proportionally more in total R&D than for large entities. Second, R&D by SMEs may be more specific, requiring more specialised equipment. Third, because SMEs are more likely to do collaborative research with other organisations, they need to spend more on the equipment to facilitate the collaboration.

Table 7.10 R&D cost structure

Cost item	All	Large	SME	Significance of difference between large firms and SMEs
	% (95% confidence level)	% (95% confidence level)	% (95% confidence level)	p-value
Rent, building, plant and machinery	11.0 (4.2–17.7)	11.0 (3.9–18.1)	11.0 (9.2–12.8)	0.996
Skilled labour	56.8 (44.6–69.0)	56.9 (44.1–69.6)	55.0 (51.5–58.6)	0.786
Feedstock	5.7 (0.9–10.4)	5.8 (0.8–10.1)	3.4 (2.3–4.5)	0.369
Other general material inputs	6.5 (3.9–9.1)	6.4 (3.7–9.1)	8.7 (6.9–10.5)	0.176
Specialised technical or laboratory equipment	2.5 (1.3–3.7)	2.4 (1.2–3.6)	4.8 (3.5–6.2)	0.008
Collaboration with other firms or researchers	2.8 (1.3–4.2)	2.7 (1.1–4.2)	4.5 (3.1–5.6)	0.086
Contracted-out R&D	12.1 (5.7–18.4)	12.2 (5.5–18.8)	9.6 (6.9–12.3)	0.471
Purchase of rights to IP / licensing costs	0.3 (0.1–0.4)	0.2 (0.1–0.3)	1.4 (0.8–2.0)	0.000
Other	2.4 (1.0–3.9)	2.5 (0.9–4.0)	1.6 (0.8–2.4)	0.341
Total	100.0	100.0	100.0	–

Source: R&D TI survey 2015.

Another difference between large firms and SMEs was in their spending on purchasing IP rights or on licensing costs (0.2% for large firms versus 1.4% for SMEs; a p -value of 0 indicates a statistically significant difference).

Of cost items, skilled labour was the most sensitive to price/cost changes. With a hypothetical 20% reduction in its cost, the use of skilled labour would increase by 22% on average (95% CI 14.7% to 29.2%) (Table 7.11). This was particularly the case for SMEs, for which the increase in demand would be 31.9% (95% CI 27.9% to 35.9%), while for large entities it would be 21.5% (95% CI 14% to 29%). The difference in response to a labour price change between large firms and SMEs was statistically significant (with a p -value of 0.015).

By contrast, demand for all other R&D input items was inelastic with respect to the price/cost change. With a 20% reduction in an individual cost item, the increase in demand was 5% or less.

Table 7.11 Increase in R&D spending in response to a 20% reduction in cost

Cost item	All	Large	SME	Significance of difference between large firms and SMEs
	% (95% confidence interval)	% (95% confidence interval)	% (95% confidence interval)	p-value
Rent, building, plant and machinery	3.8 (1.9–5.6)	3.7 (1.8–5.6)	5.4 (3.7–7.0)	0.186
Skilled labour	22.0 (14.7–29.2)	21.5 (14.0–29.0)	31.9 (27.9–35.9)	0.015
Feedstock	0.7 (0.3–1.0)	0.6 (0.2–1.0)	1.9 (1.0–2.8)	0.006
Other general material inputs	3.3 (1.1–5.5)	3.2 (0.9–5.5)	5.8 (4.2–7.4)	0.071
Specialised technical or laboratory equipment	4.9 (1.5–8.2)	4.8 (1.2–8.3)	6.3 (4.8–7.9)	0.443
Collaboration with other firms or researchers	5.0 (2.3–7.8)	5.1 (2.2–7.9)	4.6 (3.1–6.1)	0.774
Contracted-out R&D	5.7 (3.1–8.4)	5.6 (2.9–8.4)	7.3 (4.6–9.9)	0.404
Purchase of rights to IP / licensing costs	1.7 (0–3.7)	1.7 (0–3.8)	1.9 (1.1–2.7)	0.899
Other	0.8 (0.1–1.5)	0.8 (0.1–1.5)	0.9 (0.2–1.5)	0.884
Total ^a	19.2 (14.1–24.3)	18.8 (13.4–24.1)	29.3 (26.2–32.4)	0.000

^a Calculated by applying the individual firms' cost structure to the responses for individual items.

Sources: R&D TI survey 2015 and CIE calculations.

Applying the cost structure summarised in Table 7.10 and the results summarised in Table 7.11, we estimated the overall change in R&D expenditure in response to the 20% reduction in cost (reported in the last row of Table 7.11).

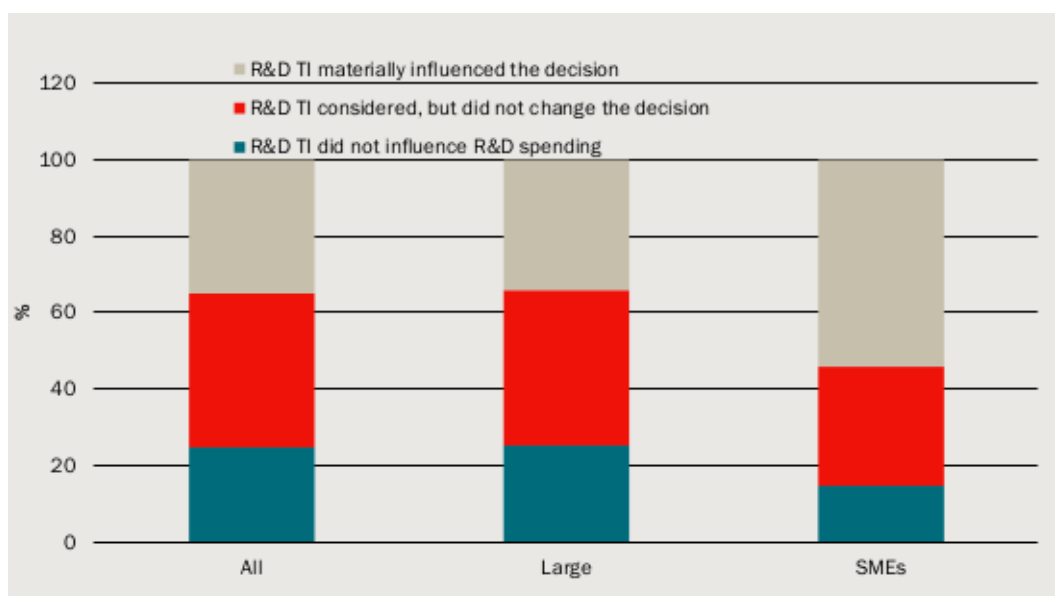
On average, a 20% reduction in R&D costs would lead to an increase in R&D by 19.2% (95% CI 14.1% to 24.3%), or an elasticity of 0.96. SMEs' demand for R&D was more sensitive to cost change: a 20% reduction in cost would lead to a 29.3% increase in R&D, or an elasticity of almost 1.47. The difference between large firms and SMEs was statistically significant (with a p -value of close to 0).

This overall responsiveness, estimated directly from the answers in the survey, gives an upper bound of the likely additionality of R&D, which is discussed in later chapters.

Impact of R&D Tax Incentive programme

Another striking result from the survey is that only about one-third of R&D spending decisions (weighted by R&D expenditure) were materially influenced by the R&D TI programme (Chart 7.12). The programme did not influence about one-quarter of R&D spending decisions at all, while for another 40% of decisions the programme was considered but did not change the decision. As a result, only 35% (95% CI 21.5% to 48.5%) of R&D spending was materially influenced by the R&D TI programme.

Chart 7.12 Influence of R&D Tax Incentive programme on R&D decisions



Note: Weighted by R&D expenditure.

Data source: R&D TI survey 2015.

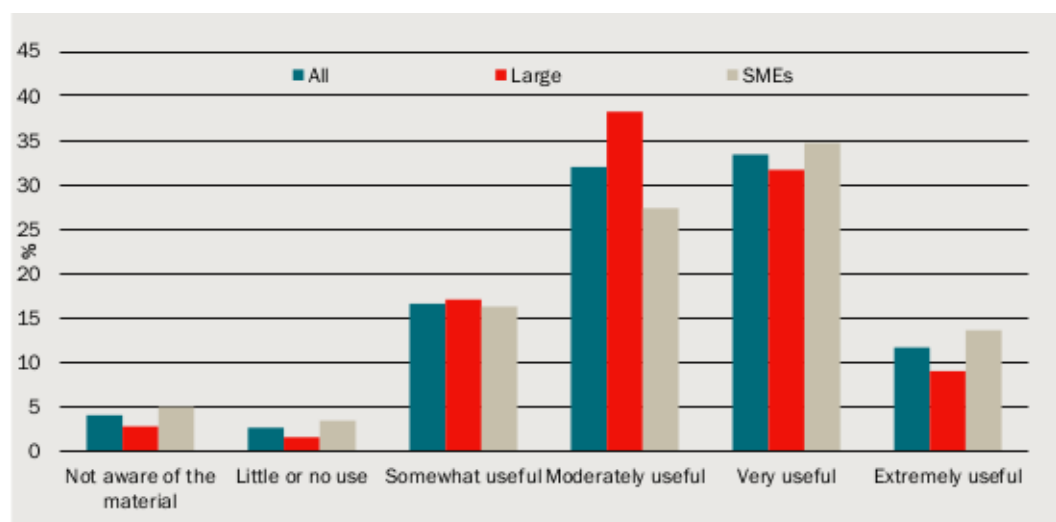
It is also evident from Chart 7.12 that the programme had a higher influence on R&D spending decisions by SMEs: 54% of their R&D decisions were materially influenced by the programme, compared to 34.1% for large entities (the difference was statistically significant, with a p -value of 0.009).

Usefulness of the guidance material

Question 24 of the R&D TI survey asked respondents to rate the usefulness of guidance material on a scale from 1 (little or no use) to 5 (extremely useful), along with a

separate category of ‘not aware of the material’. Chart 7.13 shows the percentage shares of usefulness scores for all firms, large firms and SME.

Chart 7.13 How useful was the guidance material?



Note: Percentage shares of usefulness scores for all, large and SME respondents.

Data source: R&D TI survey 2015

Among all the 785 respondents, about 45% (48.2% of SMEs and 40.6% of large firms) rated the guidance material as ‘very useful’ or ‘extremely useful’.

Proportionally more SMEs rated the guidance material as ‘very useful’ (34.7%) or ‘extremely useful’ (13.6%) than large firms (31.6% and 9%, respectively). The difference in ratings of ‘extremely useful’ between large firms and SMEs was statistically significant (p -value 0.038).

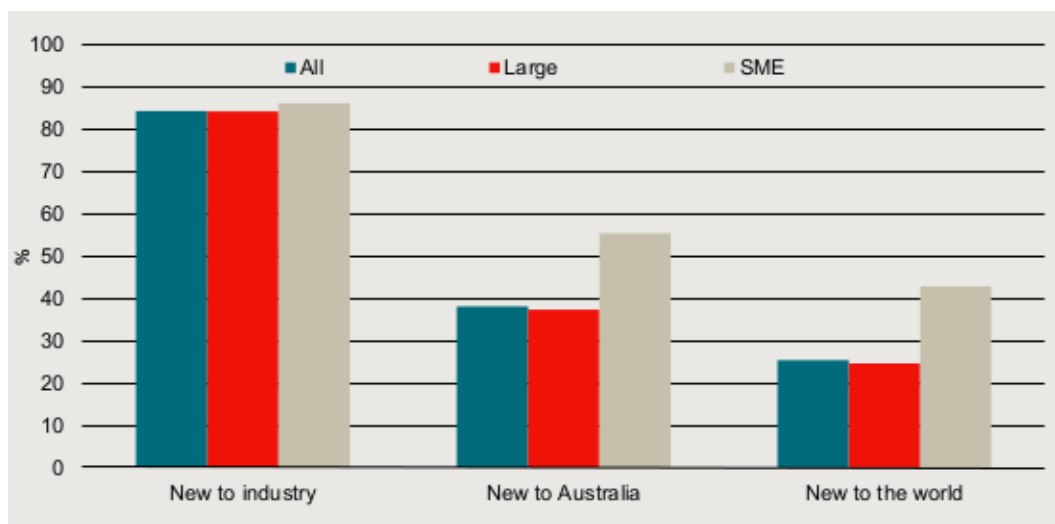
On the other hand, proportionally more large firms rated the guidance material as ‘moderately useful’ (38.2%) than SMEs (27.3%), and the difference was statistically significant (p -value 0.001). A slightly higher proportion of large firms (17%) rated the material as ‘somewhat useful’ than SMEs (16.2%), but the difference was not statistically significant.

As a result, on average SMEs rated the guidance material more useful (R&D expenditure weighted average score of 3.4; that is, about halfway between ‘moderately useful’ and ‘very useful’; 95% CI 3.27 to 3.53) than large firms (average score of 2.83; 95% CI 2.41 to 3.26), and the difference was statistically significant (p -value 0.013).

For all respondents, the R&D expenditure weighted average score of usefulness was 2.86—that is, slightly lower than ‘moderately useful’ (95% CI 2.44 to 3.27).

R&D outcomes

Overall, about 84% (95% CI 78.7% to 89.7%), 38% (27.7% to 48.3%) and 25% (17.6% to 33%) of total R&D spending resulted in products, services, processes or platform technologies that were new to industry, Australia and the world, respectively (Chart 7.14).

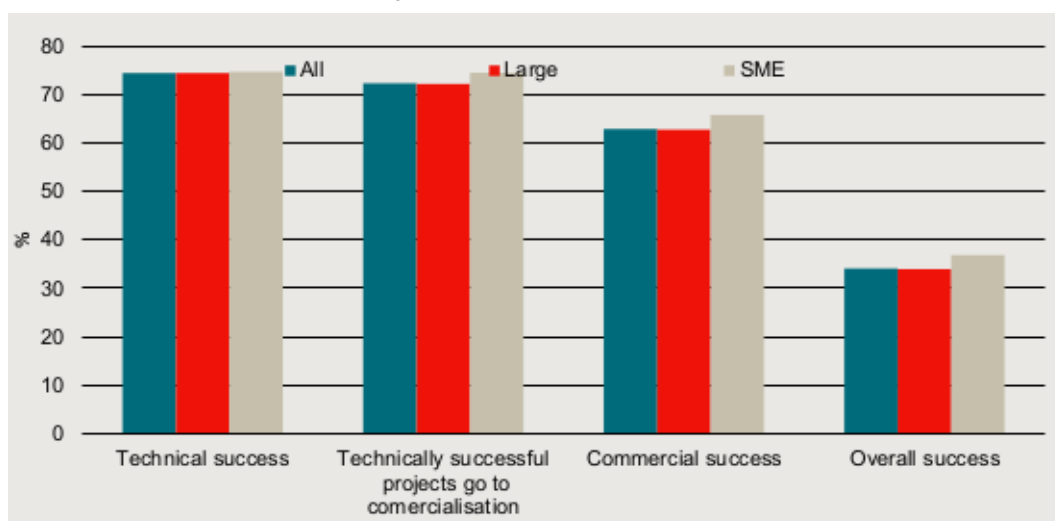
Chart 7.14 How new are the R&D outcomes?

Note: Weighted by R&D expenditure.

Data source: R&D TI survey 2015.

It is also evident from Chart 7.14 that R&D undertaken by SMEs generated higher novelty than that by large entities. Over 55% and 42.8% of SMEs' R&D spending produces products, services, processes or platform technologies that are new to Australia and to the world, respectively, compared to only 37.3% and 24.6% of spending by large entities. The differences were statistically significant (p -values 0.003 and 0, respectively).

Chart 7.15 shows the average success rates of R&D projects at different stages of R&D. About three-quarters (95% CI 68.5% to 80.7%) of R&D projects achieved technical success. Among the technically successful projects, slightly less than three-quarters (95% CI 64.2% to 80.8%) went into commercialisation. Only 63% (95% CI 50.2% to 75.8%) of commercialised projects achieved commercial success. This led to an overall success rate of 34% (95% CI 30.1 to 56.1%).

Chart 7.15 Success of R&D projects

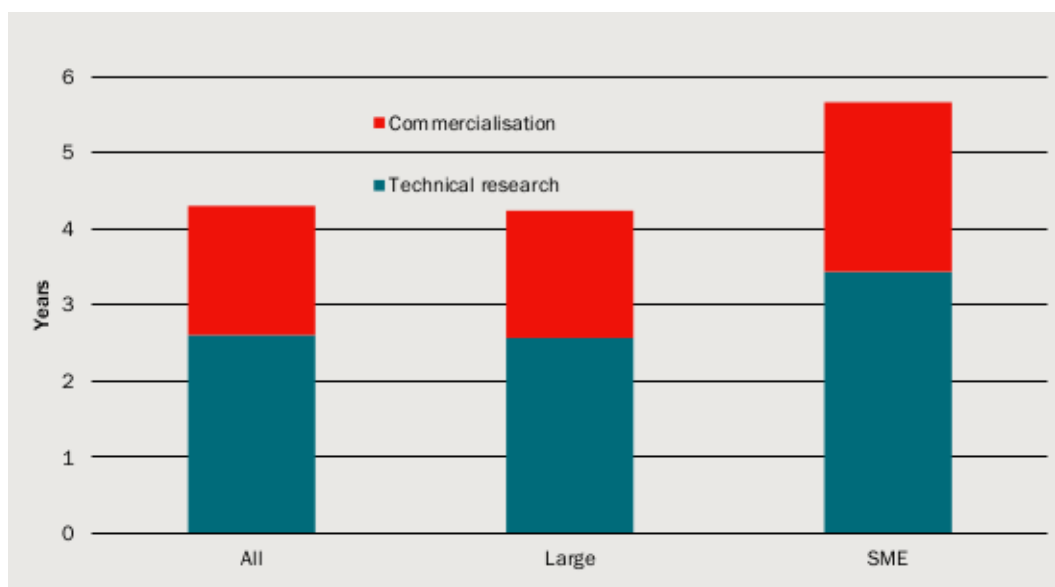
Note: Weighted by R&D expenditure.

Data source: R&D TI survey 2015.

R&D projects conducted by SMEs achieved a slightly higher overall success rate than those conducted by large entities (37% versus 34%). This was mainly due to a higher proportion of technically successful projects going into commercialisation and a higher success rate of commercialisation by SMEs. However, the difference was not statistically significant.

On average, technical research took about 2.6 years (95% CI 2.1 to 3.0 years), while commercialisation took about 1.7 years (95% CI 1.3 to 2.1 years) (Chart 7.16). R&D projects by SMEs lasted longer, with technical research taking 3.4 years and commercialisation 2.2 years. This may be due to the limited resources available to SMEs. The difference in the length of technical research is not statistically significant, while the difference in the length of commercialisation is (p -value 0.05).

Chart 7.16 Average length of R&D projects



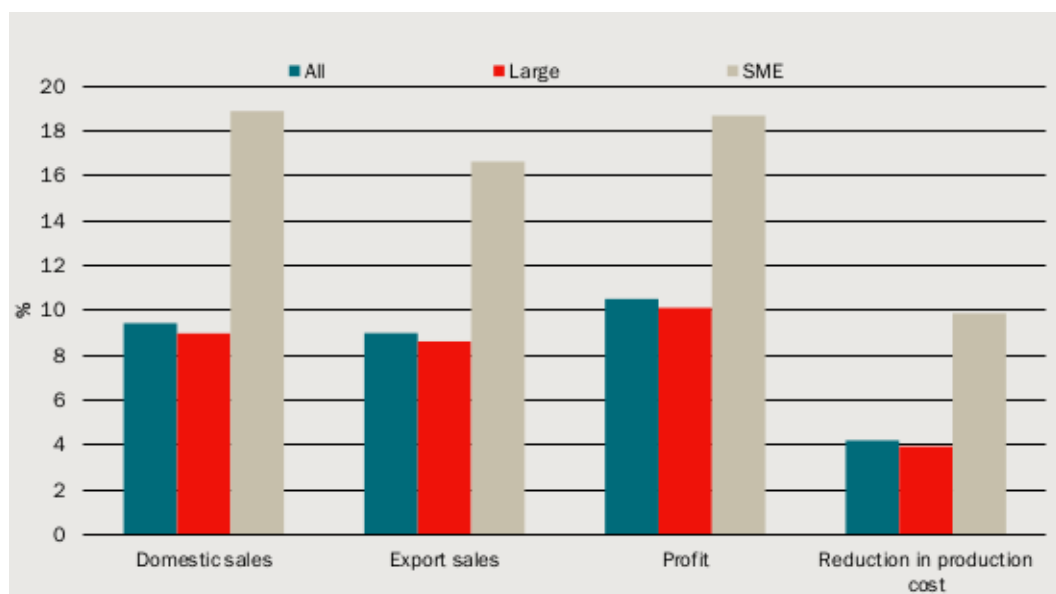
Note: Weighted by R&D expenditure.

Data source: R&D TI survey 2015.

Typically, an average firm's R&D was expected to increase the firm's domestic sales, export sales and profit by 9.4% (95% CI 7.2% to 11.6%), 9% (6.3% to 11.7%) and 10.5% (8% to 13%), respectively, and to reduce production costs by 4.2% (0.2% to 8.2%) five years after completion of the R&D (Chart 7.17).

R&D is particularly beneficial to SMEs. Potential increases in domestic sales, export sales and profit were reported to be 18.9%, 16.6% and 18.7%, respectively, while the potential reduction in production costs was 9.9%. The differences in the R&D impacts on large firms and SMEs are all statistically significant.

Chart 7.17 Potential impact of R&D in a typical year



Note: Weighted by R&D expenditure.

Data source: R&D TI survey 2015.

Knowledge flows and spillovers

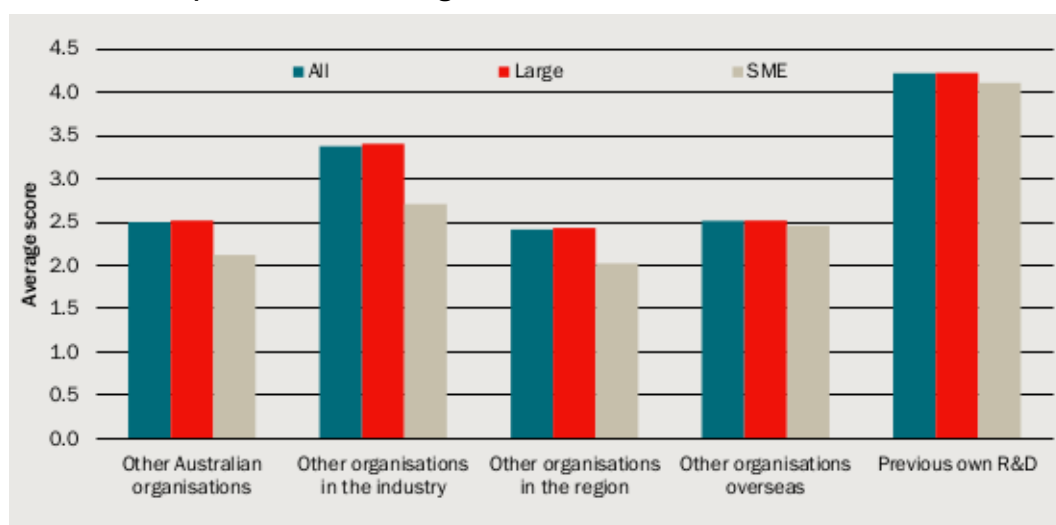
Knowledge inputs

Chart 7.18 summarises the importance that respondents attributed to the sources of knowledge inputs into their R&D activities. Importance was rated using a scale from 1 (not important) to 5 (extremely important).

The results indicated that firms' own R&D undertaken previously was rated the highest, with a weighted average score of 4.2 (95% CI 4.0 to 4.5), which was slightly higher than very important (a score of 4). It was followed by R&D undertaken by other organisations in the respondents' industries, with an average score of 3.4 (95% CI 3.1 to 3.7), which was somewhere between moderately important (a score of 3) and very important. Other sources of knowledge were rated on average at 2.5 or lower, or less than moderately important. This may indicate that spillovers between organisations are limited.

SMEs in general rated the various sources of knowledge with lower scores than did large entities, especially for R&D undertaken in Australia by other organisations within their own industries or in their regions. The differences in ratings between large firms and SMEs were statistically significant for 'R&D undertaken by other organisations in Australia', 'R&D undertaken by other organisations in your industry or sector' and 'R&D undertaken by other organisations in your region'.

Chart 7.18 Importance of knowledge sources

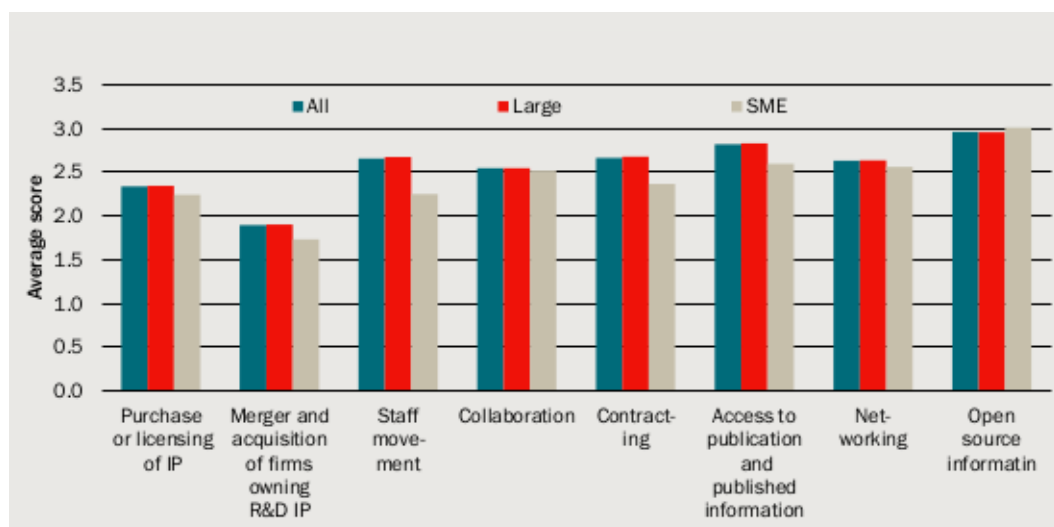


Note: R&D expenditure weighted average score of importance: 1—not important, 2—somewhat important, 3—moderately important, 4—very important, 5—extremely important.

Data source: R&D TI survey 2015.

The observation that knowledge spillovers are limited was also supported by respondents' ratings of the importance of accessing external sources of R&D information (Chart 7.19). All ways of accessing external sources were rated with an average score lower than 3 (moderately important). Accessing open source information was rated the highest at 3 on average (95% CI 2.6 to 3.3), followed by access to key publications or published patent information (average score of 2.8; 95% CI 2.6 to 3.1), staff movement and contracting of R&D activities (both with average scores of 2.7; 95% CI 2.4 to 2.9 for staff movement and 95% CI 2.1 to 3.2 for contracting of R&D), and explicit collaboration (average score of 2.6; 95% CI 2.1 to 3.0).

Chart 7.19 Importance of accessing external information

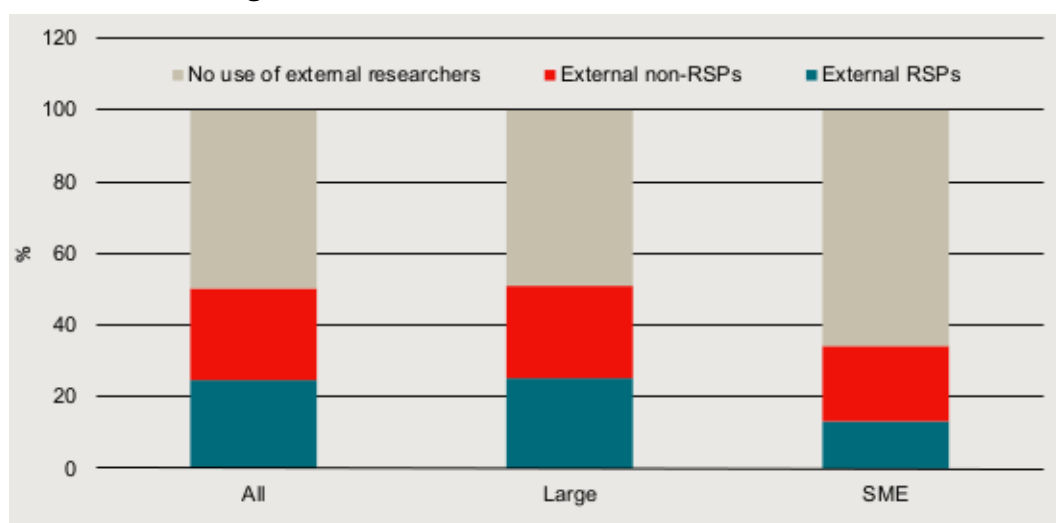


Note: R&D expenditure weighted average score of importance: 1—not important, 2—somewhat important, 3—moderately important, 4—very important, 5—extremely important.

Data source: R&D TI survey 2015.

SMEs placed slightly more importance on open source information than large entities, which is a reflection of the limited resources available to them, and similar importance on collaboration, which is consistent with the finding that SMEs spend proportionally more on collaboration (as reported in Table 7.10). Because of their limited resources, SMEs placed less importance on other sources of external information, such as purchasing or licensing IP, mergers and acquisitions of organisations owning IP, staff movement and contracting of R&D. However, the differences in the ratings between large firms and SMEs were not statistically significant, except for staff movement.

A low rate of engaging external researchers may also support a conclusion that spillovers are limited. Chart 7.20 shows the respondents' experience of working with external researchers. On average, only about half of firms (95% CI 33.6% to 66.9%) had worked or are working with external researchers, of which about half are Research Service Providers (RSPs). SMEs had significantly less experience of working with external researchers: only a third of them had worked or were working with external researchers.

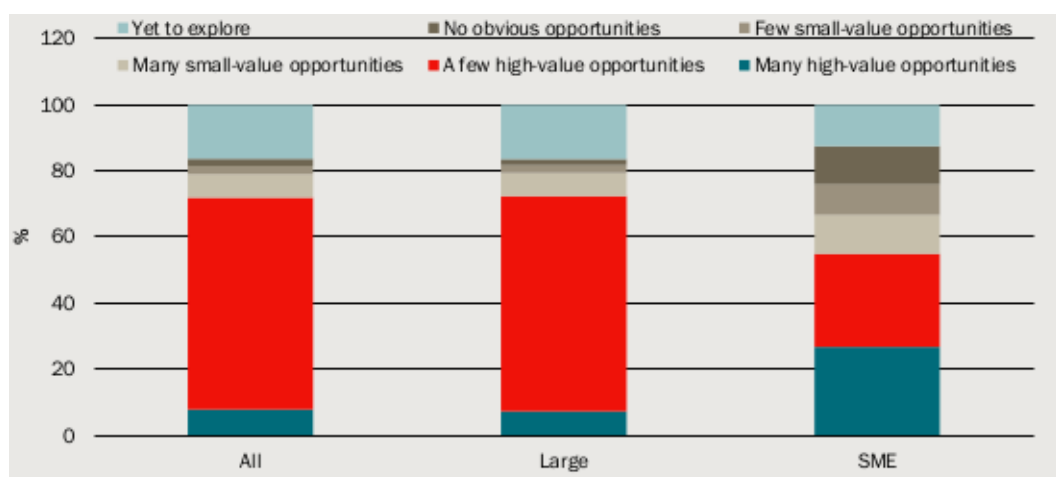
Chart 7.20 Working with external researchers

RSP = Research Service Provider.

Note: Weighted by R&D expenditure.

Data source: R&D TI survey 2015.

Charts 7.21 and 7.22 provide some explanation about why firms have not engaged more with external researchers. About two-thirds of large entities saw only a few highly valuable opportunities for such collaboration. Although about 27% of SMEs saw many highly valuable opportunities for more collaboration, they generally lacked funding (the highest score in Table 7.22).

Chart 7.21 The scope to increase the level of collaboration

Note: Weighted by R&D expenditure.

Data source: R&D TI survey 2015

Table 7.22 Importance of factors restricting collaboration with external researchers

Restricting factor	All	Large	SME	Significance of difference between large firms and SMEs
	Weighted average score (95% confidence interval)			p-value
Different objectives	2.67 (2.30–3.01)	2.67 (2.29–3.05)	2.84 (2.54–3.13)	0.502
Cultural differences	2.57 (2.17–2.97)	2.58 (2.17–2.99)	2.35 (2.04–2.66)	0.386
Different expectation on timing	2.99 (2.69–3.29)	2.99 (2.69–3.30)	2.99 (2.71–3.27)	0.991
External researchers' lack of facilities or specialist equipment	2.24 (1.75–2.73)	2.25 (1.74–2.75)	2.09 (1.82–2.36)	0.597
External researchers' lack of special knowledge or experience	2.20 (1.59–2.81)	2.19 (1.56–2.81)	2.56 (2.25–2.86)	0.302
IP issues	2.59 (2.17–3.01)	2.59 (2.16–3.03)	2.47 (2.17–2.78)	0.664
Business is unsure of the potential benefits of using external researchers	1.77 (1.38–2.17)	1.77 (1.36–2.18)	1.96 (1.75–2.16)	0.431
Business is unaware of external research services	1.91 (1.32–2.50)	1.91 (1.30–2.52)	1.90 (1.71–2.09)	0.987
Lack of funds	2.92 (2.19–3.66)	2.90 (2.15–3.66)	3.55 (3.26–3.84)	0.115

Note: R&D expenditure weighted average score of importance: 1—not a barrier, 2—a small barrier and easily overcome, 3—significant barrier but can be readily overcome, 4—large barrier and not easily overcome, 5—large barrier and cost of overcoming outweighs the benefit.

Data source: R&D TI survey 2015.

Knowledge protection

Consistent with the observations from the survey about firms as receivers of knowledge from external sources, firms as producers of knowledge have implemented measures to protect their R&D outcomes, which may limit the possibility of spillovers of knowledge from the producer to others. Table 7.23 reports the forms of protection that the respondents used to protect their R&D outcomes from being copied by others. Every respondent used at least one form of protection as listed in the table. The most common form of protection was the requirement for high investment by others to replicate results. About two-thirds of respondents thought this was effective.

Another observation from Table 7.23 is that SMEs had relatively less protection of R&D outcomes. Almost all of the forms of protection had a lower incidence rate among SMEs than among large entities.

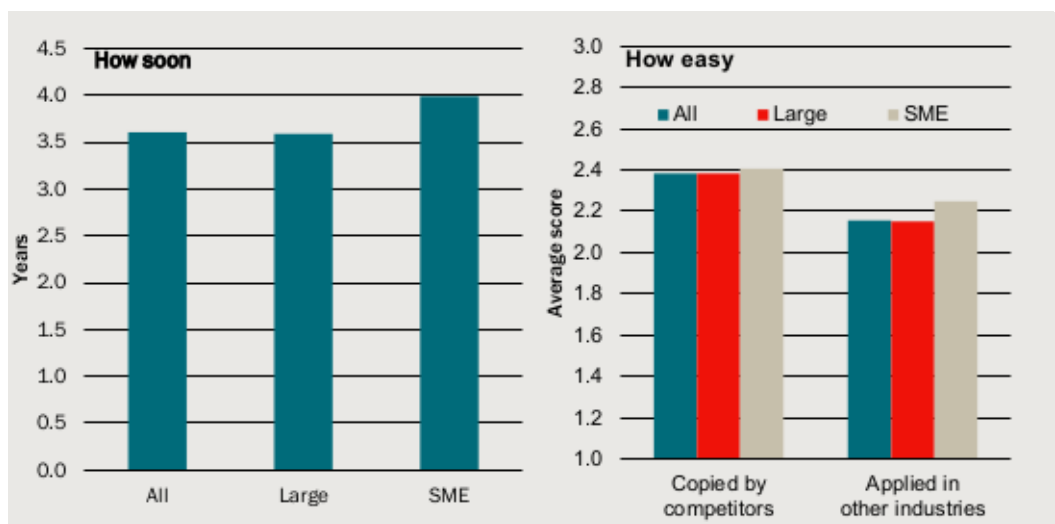
Because of the various forms of protection placed on R&D outcomes, it takes 3.5 years for large firms' competitors and 4 years for SMEs' competitors to catch up or copy results after R&D is commercialised (the left panel in Chart 7.24), and it is not easy for competitors to copy—a score of 2.4 is between 'possible, but with some difficulty' (score of 2) and 'somewhat easy' (score of 3) (the right panel of Chart 7.24).

Table 7.23 Protection of R&D outcomes

Protection measure	All	Large	SME	Significance of difference between large firms and SMEs
	% (95% confidence interval)	% (95% confidence interval)	% (95% confidence interval)	p-value
Patents in Australia	40.2 (25.0–55.5)	40.6 (24.5–56.6)	32.6 (26.3–38.9)	0.367
Patents overseas	38.1 (22.8–53.5)	38.5 (22.4–54.6)	29.7 (23.4–36.0)	0.315
Other IPs	56.2 (39.7–72.7)	56.4 (39.2–73.7)	50.7 (44.1–57.2)	0.534
Dedicated natural resources	12.4 (1.6–23.1)	12.7 (1.5–23.9)	5.0 (2.4–7.7)	0.194
Key technological input	43.0 (25.2–60.9)	43.8 (25.2–62.4)	25.6 (19.9–31.2)	0.065
Other essential inputs	25.6 (6.1–45.0)	26.2 (6.0–46.4)	10.8 (6.7–14.9)	0.143
Complex production process	42.6 (25.0–60.3)	43.1 (24.7–61.5)	31.9 (25.5–38.3)	0.252
Secrecy of R&D outcomes	53.5 (36.9–70.1)	53.8 (36.5–71.1)	47.1 (40.5–53.7)	0.475
High investment requirement	66.0 (51.7–80.4)	66.9 (52.0–81.8)	46.8 (40.1–53.4)	0.015
Dedicated client base	16.8 (9.0–24.6)	15.7 (7.8–23.6)	41.9 (35.4–48.4)	0.000
Quick to market	38.0 (19.4–56.7)	38.1 (18.6–57.7)	35.4 (29.0–41.7)	0.792
Other	6.3 (1.9–12.5)	6.3 (0.0–12.7)	8.1 (4.6–11.6)	0.619

Note: Weighted by R&D expenditure.

Source: R&D TI survey 2015.

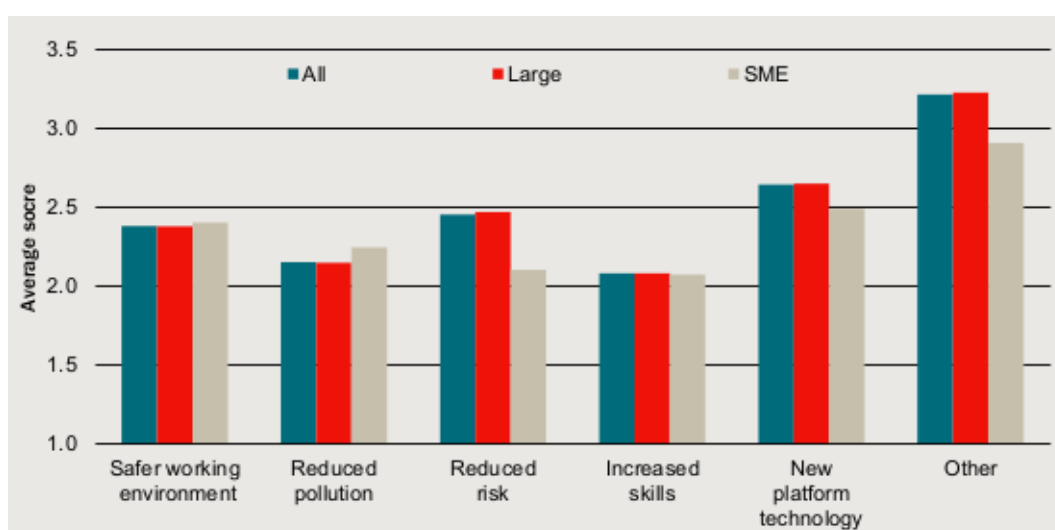
Chart 7.24 How soon and how easily can competitors catch up or copy?

Note: Weighted by R&D expenditure; easiness score: 1—impossible, 2—possible, but with some difficulty, 3—somewhat easy, 4—moderately easy, 5—very easy.

Data source: R&D TI survey 2015.

The time needed for competitors to catch up was equivalent to more than 80% of the time taken by large entities to finish a whole research project (4.3 years from technical research to completion of commercialisation; Chart 7.16), and equivalent to 70% of the time taken by SMEs to complete a project (5.6 years; Chart 7.16).

Chart 7.25 shows other non-financial impacts of R&D activities that may be classified as spillover effects, including health, safety and environmental effects. On average, the respondents gave an importance score of 2.7 or less for most of the effects except 'other', which was lower than a moderate impact.

Chart 7.25 Other effects of R&D

Note: R&D expenditure weighted average score: 1—no impact, 2—minor impact, 3—moderate impact, 4—high impact, 5—very high impact

Data source: R&D TI survey 2015

8 *Estimating additionality from the survey results*

The additionality rate under the R&D TI was estimated based on the results of the survey of recipient firms, using seven alternative approaches. The rate was found to be between 0.3 and 1.5.

The estimated additionality rate is greater for SMEs (0.6–1.5) than for large firms (0.3–0.9). The rates selected for the evaluation were 0.5 for large firms and 1 for SMEs. The average rate for all firms was 0.82.

Analysis of alternative thresholds for the cut-off point between large and small firms (defined in terms of R&D expenditure and turnover) found that there was not a clear optimal cut-off. The current threshold of \$20 million turnover for alternative treatment of firms under the policy is within the bounds of an acceptable cut-off to maximise additional R&D.

Interpreting survey and model results

The amount of extra money spent on R&D as a share of the financial incentive provided by the government to firms is referred to in this report as the ‘additionality rate’. In the discussion of the additionality rate in this report, we specifically refer to the dollar increase in R&D for each dollar of tax revenue forgone. Thus, an additionality rate of 0.8 means that there is 80 cents of additional R&D expenditure for each dollar of tax revenue forgone. This is illustrated in Chart 2.5 in Chapter 2.

The results from the survey contained a number of sources of information that allowed for a variety of approaches to estimating additionality. Table 8.1 provides a brief introduction to those approaches.

Table 8.1 Methods of estimating additionality

Method	Method label	Note
Direct method	A	Directly using the R&D cost structure (Q15) and the effect of cost reductions on spending on R&D components (Q16) to work out the additionality (more R&D spending due to cost reduction as a result of the R&D TI)
Simple model	B	Applying the share of firms that considered the R&D TI in their R&D decision (Q22) to the results from Method A
	C	Applying the share of firms for which the R&D TI materially influenced the R&D decision (Q22) to the results from Method A
	D	Further applying firm constraints to resources and opportunities (from Q14) to the results from Method B
	E	Further applying firm constraints to resources and opportunities (from Q14) to the results from Method C
Structural model	F	Estimating additionality based on the firm's profit maximisation and R&D cost minimisation behaviour, deriving the price elasticity for the firm's products and/or services from the survey
	G	Estimating additionality based on the firm's profit maximisation and R&D cost minimisation behaviour, assuming that the firm does not affect the market price

Source: The CIE. See Appendix G for details of calculations.

Method A

As discussed in Chapter 7, additionality can be estimated directly from responses to questions about the reduction in the costs of individual R&D inputs (Question 16). This is because the R&D TI reduces the cost of doing R&D by providing greater than normal cost deductions. This *direct method* (Method A) also uses information on R&D cost structures provided by survey respondents in response to Question 15 to estimate the change in aggregate R&D activity in response to cost reductions.

Generally, additionality estimated by this direct method is the upper bound of the additionality rate estimates, as it does not impose any constraints on inputs (such as labour) to additional R&D.

Methods B and C

Further to the direct method, information about whether the R&D TI affects individual entities' R&D decision-making (as given in response to Question 22) could be used to provide a better estimate of the additionality rate.

Question 22 asked respondents to give the proportion of their R&D expenditure for three cases:

- R&D TI was not considered

- R&D TI was considered, but did not change the decision to fund the R&D²¹
- R&D TI was considered and materially influenced the decision to fund the R&D.

It is obvious that the first case should be excluded from additionality calculations, as the R&D TI did not influence the R&D decision and thus there is no additionality for this proportion of R&D. This method (adjusting the direct response by the proportion in which the R&D TI was not considered in the R&D decision) is called Method B.

It is arguable that the second case should also be excluded from the additionality calculations, as the R&D TI did not change the decision to fund R&D. In other words, the R&D spending would have happened regardless, so no extra R&D was induced by the R&D TI. This leads to Method C, which includes only the proportion of R&D spending that has been materially influenced by the R&D TI.

It is to be expected that additionality estimated by Method C will be lower than that estimated by Method B, which is in turn lower than that estimated by Method A.

Methods D and E

Each of the methods A, B and C may overlook important constraints on R&D activity. For example, expanding R&D means employing more people with special expertise. In many cases, incremental R&D may lead to labour constraints or higher wages. Similarly, but on the output side, firms may choose not engage in more R&D even if R&D is cheaper, simply because further R&D might not bring about higher profits.

These two types of constraints—resource availability and opportunity and motivation—were explicitly asked about in the survey (Question 14). The calculation of additionality can thus be modified by incorporating these constraints.

Applying these constraints to Methods B and C leads to Methods D and E, respectively. It is expected that the additionality rate estimated by Methods D and E will be lower than that estimated by Methods B and C, respectively.

Methods F and G

A more complex approach to calculating additionality can be used by including more information from the survey. In this structural modelling approach, a firm's R&D decisions are made in two stages. First, the firm tries to maximise its profit by choosing various inputs including aggregate R&D activity. Next, the firm chooses various R&D inputs to minimise the R&D cost for given level of aggregate R&D activity.

This structural approach uses more information gathered from the survey. There are two variants of this approach. The first (Method F) uses the demand elasticity of the firm's products and services derived from the survey (in particular, Question 30), along with the cost structure of the firm. The second (Method G) assumes perfectly elastic demand—that is, change in the firm's production does not affect the market price.

²¹ This option implies that the firm was aware of the R&D TI, and considered its implications, at the time of the decision, but that ultimately this did not change the firm's decision.

Further technical details of the methods are in Appendix G.

Estimated additionality rates

Table 8.2 reports the average additionality rates (along with the 95% confidence intervals) estimated by each of the methods. Chart 8.3 shows the frequency distribution of firms' additionality rates for two of these methods, while Chart 8.4 shows the cumulative frequency distribution of the same results.

The additionality rate estimated based on the results of the survey of recipient firms was found to be between 0.3 and 1.5 (this is the range from large firms under Method E to SMEs under Method A). The range for SMEs (0.6–1.5, or Method E compared with Method A) is larger than the range for large firms (0.3–0.9, Method E versus Method A).

Based on this range, representative additionality rates used in the remainder of the evaluation (except for the sensitivity analysis) are 0.5 for large firms and 1 for SMEs. Using tax foregone weights, this implies that the average rate for all firms is 0.82.

It is evident that there is a wide range of additionality rate estimates for different methods, as well as for different firms. Nevertheless, in most cases the additionality rate is less than 1. For example, for the simple model in Method B about two-thirds of firms have additionality rates lower than 1, and for the structural model Method F about 58% of firms have additionality rates of 1 or lower.

Another key observation is that SMEs on average have higher additionality rates than large entities for every method.²² Under some of the methods, average and median additionality rates for SMEs are greater than 1. It is clear from Chart 8.4 that the cumulative distribution curve for SMEs lies below the curve for large entities, implying that SMEs have relatively lower incidence of low additionality rates than large entities do.

²² The *p*-values in Table 8.2 show that the responses for large and SME firms are statistically significantly different.

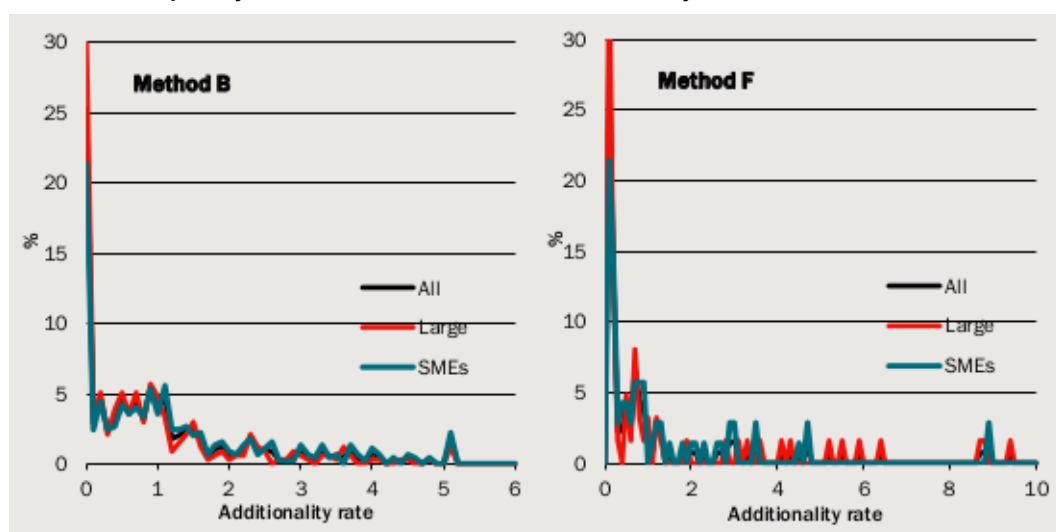
Table 8.2 Estimated additionality rates

Method label	Method	All	Large	SME	Significance of difference between large firms and SMEs p-value
		Rate (95% confidence interval)	Rate (95% confidence interval)	Rate (95% confidence interval)	
A	Direct method	0.96 (0.71–1.22)	0.94 (0.67–1.20)	1.47 (1.31–1.62)	0.000
Simple model					
B	Excluding R&D TI not considered in decision-making	0.73 (0.53–0.93)	0.71 (0.50–0.92)	1.26 (1.10–1.42)	0.000
C	Including R&D TI materially influenced decision only	0.38 (0.22–0.54)	0.36 (0.19–0.53)	0.82 (0.70–0.93)	0.000
Simple model with consideration of constraints					
D	Excluding R&D TI not considered in decision-making	0.57 (0.46–0.68)	0.55 (0.44–0.67)	0.95 (0.85–1.05)	0.000
E	Including R&D TI materially influenced decision only	0.28 (0.18–0.39)	0.27 (0.15–0.39)	0.61 (0.53–0.67)	0.000
Structural model					
F	Using demand elasticity estimated from survey	0.60 (0.15–1.04)	0.57 (0.14–1.01)	1.44 (0.69–2.18)	0.027
G	Assuming no market power	0.36 (0.15–0.56)	0.33 (0.11–0.55)	0.96 (0.66–1.27)	0.009

Note: Results are a weighted average, weighted by R&D expenditure.

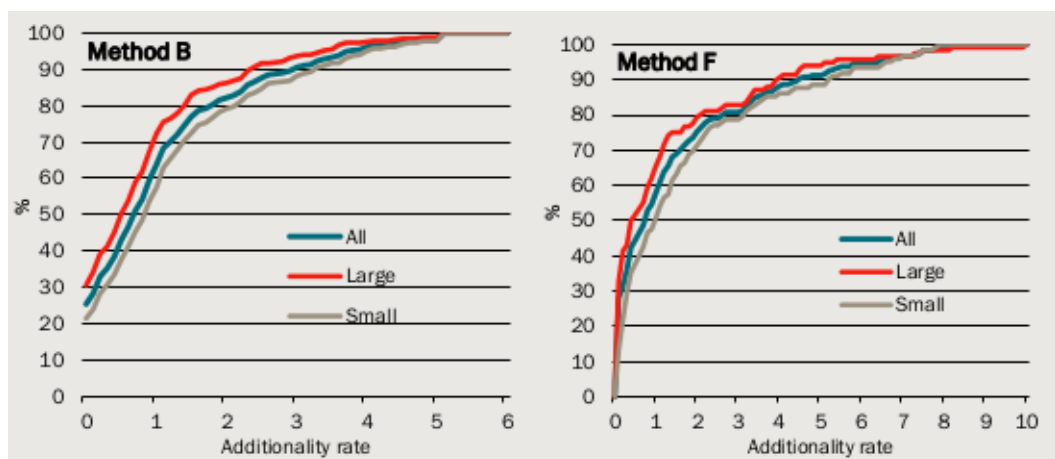
Sources: R&D TI survey 2015 and CIE calculations.

Chart 8.3 Frequency distribution of firm-level additionality rate



Data sources: R&D TI survey 2015 and CIE calculations.

Chart 8.4 Cumulative distribution of firm level additionality rate



Data sources: R&D TI survey 2015 and CIE calculation.

An investigation into the relationship between firm characteristics and additionality found that loss-making SMEs tend to have higher additionality rates than profitable SMEs. As shown in Chart 8.5, that pattern persists for all the estimation methods.

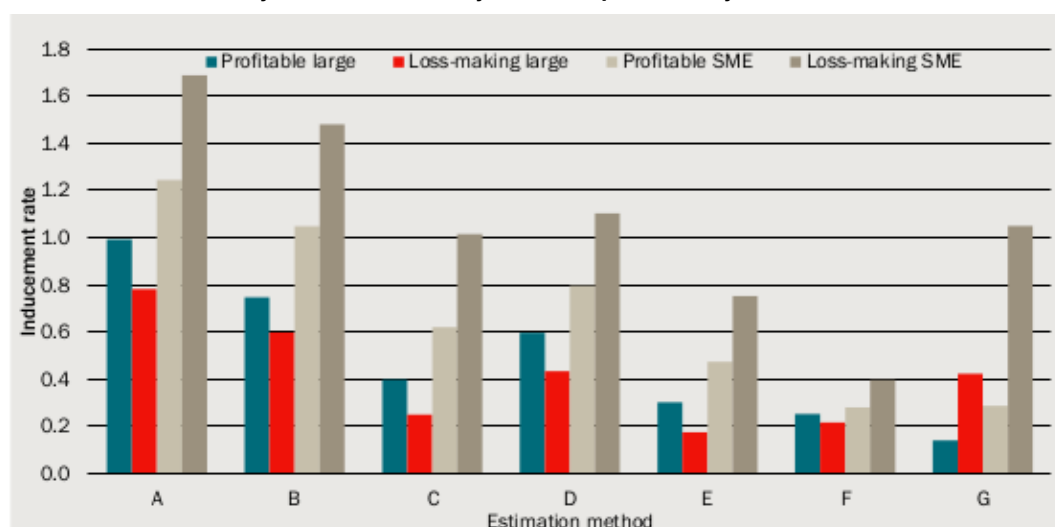
The average additionality rates across the alternative estimation approaches were:

- 0.5 for large, profitable firms
- 0.4 for large, loss-making firms
- 0.7 for small, profitable firms
- 1.1 for small, loss-making firms.

The results may be driven by two factors. First, loss-making SMEs are cash constrained and so are more responsive to tax benefits. Second, the R&D TI provides more tax benefits for loss-making SMEs than for those with profit. This makes the loss-making SMEs more conscious of the programme and more responsive.

This finding provides favourable support for the current policy settings, which provide a greater level of support to smaller firms, and in particular those in loss.

Chart 8.5 Additionality rate estimates by size and profitability



Data sources: R&D TI survey 2015 and CIE calculation.

Relationship between additionality and R&D expenditure and turnover

One of the major findings of the analysis is that SMEs have higher additionality rates than large firms (see chart 8.5). However, the division of firms into large and small according to their R&D expenditure with a cut-off value of \$2 million is partly arbitrary, as is the threshold used for alternative policy treatments under the R&D TI programme (an aggregated group turnover of \$20 million). Here we explore the importance of this cut-off point in terms of estimated additionality differences between SMEs and large firms.

In order to test an appropriate cut-off point to classify firms and potentially maximise additionality, we systematically changed the cut-off values for both R&D expenditure and turnover (as measured in the survey). We then recalculated the associated weighted average additionality rates for large firms and SMEs, allowing us to calculate the difference between the two rates for different cut-off values.

The cut-off value that leads to the maximum difference between large firms and SMEs would be deemed to be optimal as a policy, as differential treatment based on it would (all other factors being equal) achieve the highest additional R&D.

Charts 8.6 and 8.7 show the results for selected cut-off values of R&D expenditure and turnover, respectively. The blue and red lines denote the weighted average additionality rates of large firms and SMEs, respectively, while the grey line represents the difference in average additionality rate between large firms and SMEs (a negative value means that the rate of large firms is less than that of SMEs). The red square markers denote points at which the difference between large firms and SMEs is *not* statistically significant.

Note that, in moving along the horizontal axis, it is the cut-off point between large and small firms that varies, defined either in terms of R&D expenditure or in terms of turnover.

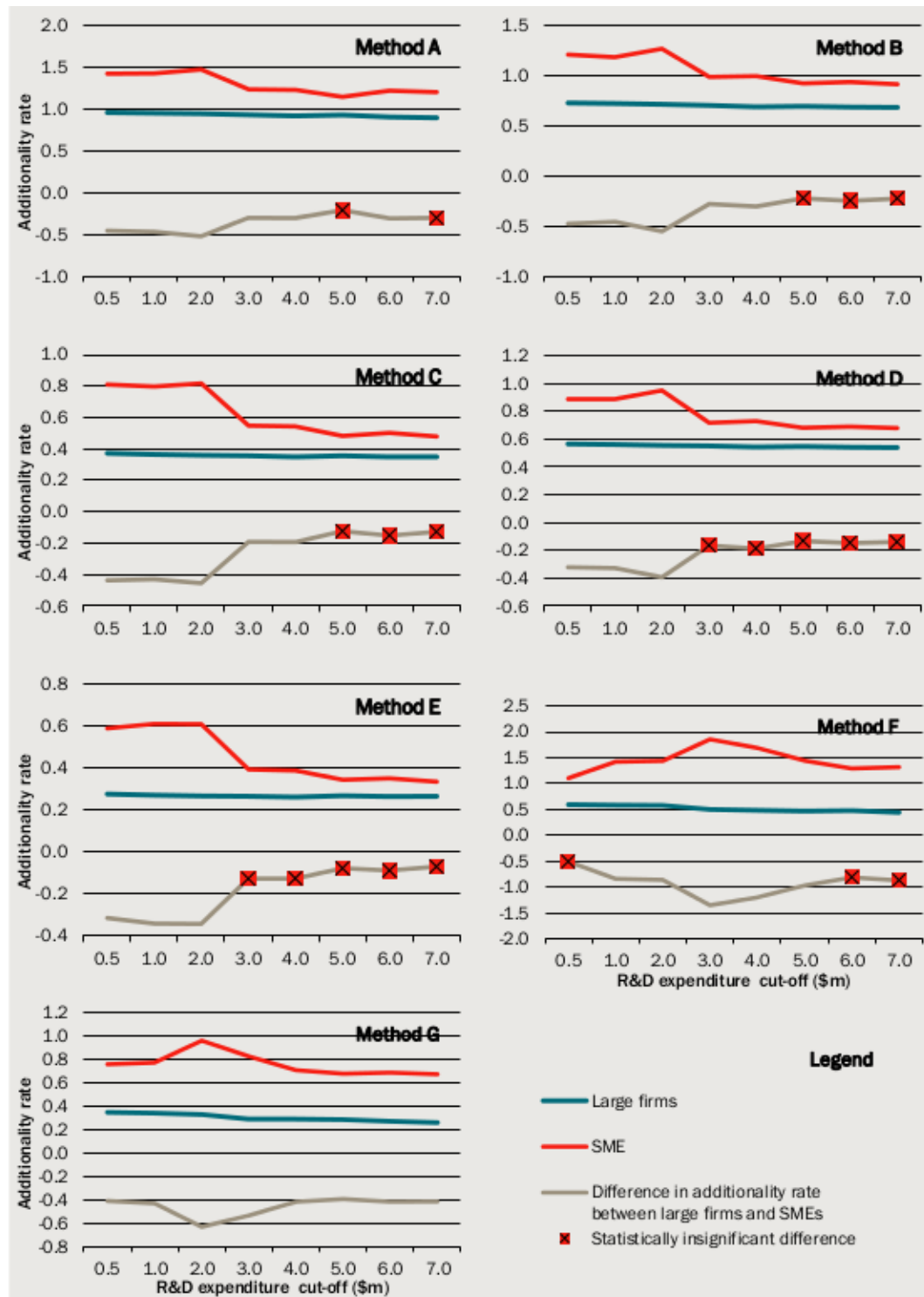
These results lead to a number of observations:

- SMEs persistently have higher additionality rates than large firms for all the selected cut-off values shown, either in terms of R&D expenditure or in terms of turnover.
- Reclassifying firms by varying the cut-off for R&D expenditure tends to lead to greater variation in the additionality rate than varying the classification according to turnover, for most of the estimation methods.
- The difference in the additionality rate becomes smaller when the R&D expenditure cut-off value is \$3 million or more. In other words, the ideal cut-off value lies somewhere below \$3 million in R&D expenditure.
- However, there is no clear cut-off point in terms of turnover.

Considerably more detailed results using more finely grained cut-off values are in Appendix H.

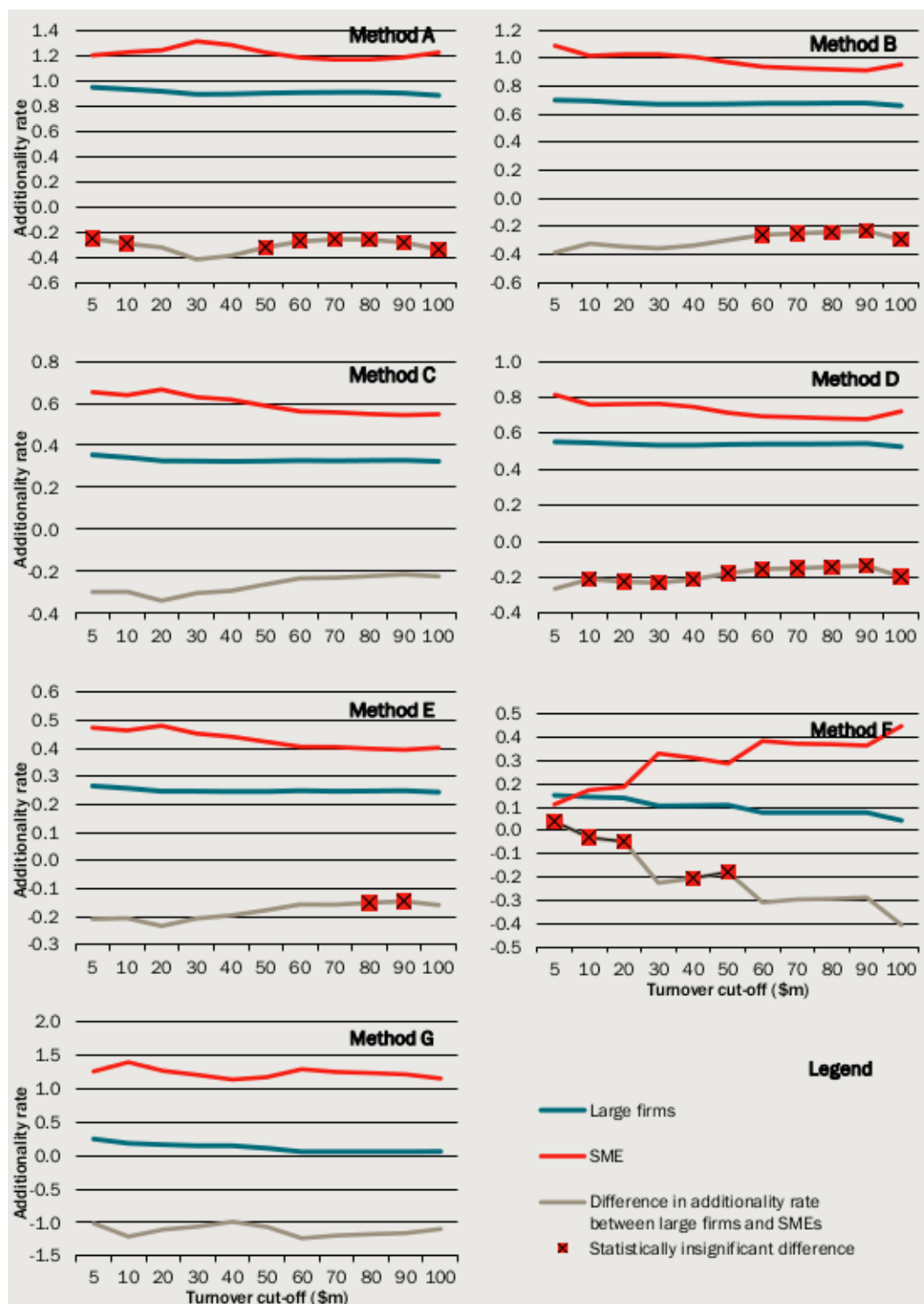
Overall, we conclude that the survey results do not provide particular reasons for altering the current cut-off point for small firms, although the results for some of the scenarios suggest that the cut-off should be slightly below \$2 million for R&D or \$20 million for turnover. This result should not be considered definitive and requires further examination as more data is generated.

Chart 8.6 Additionality rates for large and SMEs with different cut-off points, by R&D expenditure



Data source: CIE calculations.

Chart 8.7 Additionality rates for large and SMEs with different cut-off points, by turnover



Data source: CIE calculations.

9 Benefits of the R&D Tax Incentive

The benefits from the R&D TI are mainly realised through improvements in productivity as a result of additional research.

The benefits were estimated using two alternative approaches: first, by assuming that the elasticity of multifactor productivity for R&D is 0.02 (based on findings by the Productivity Commission); second, by basing them on alternative estimates of the cost reductions from research arising from the results of the survey. The range from the survey also reflected the range of results in the Productivity Commission's research.

These assumptions were applied to economic models to estimate the economy-wide benefits.

The alternative scenarios found that the annualised present value of spillover benefits from the R&D TI range from \$0.63 billion to \$4.53 billion.

Economy-wide impact scenarios

Based on the additionality findings described in the previous chapter and the survey results, we conducted an analysis to assess the overall benefits of the R&D TI to the Australian economy. To do this, we used a computable general equilibrium (CGE) model of the Australian economy, CIE-REGIONS.

The model provides a detailed account of industry activity, investment, imports, exports, changes in prices, employment, household spending and savings and many other factors. The version of the model used for this analysis identifies 58 sectors in Australia's six states and two territories. It accounts for differing economic fundamentals in the states and territories (for instance, the mining industry in Western Australia and Queensland). The model also has a detailed account of federal and state government revenues and expenditures. Further technical details of the CIE-REGIONS model are in Appendix I.

By using a CGE model, we were able to trace the implications of the R&D TI policy throughout the economy. The direct impact of the policy was modelled by applying a productivity or cost change to the economy. The data and equations in the model enabled us to trace the implications of those changes through all the sectors of the economy; that is, given that firms and consumers seek to maximise their surplus, we could trace the extent to which they will produce and consume different goods and the prices that will prevail in the market to achieve that outcome. The model also calculated the changes in returns to firms and consumers, and changes in taxes paid.

Three alternative scenarios were constructed to assess the benefits generated by the R&D TI. The scenarios effectively tested the impact of a range of alternative spillover rates. A further two scenarios were developed to examine a hypothetical alternative use of the R&D TI funding and can form an illustrative baseline for comparisons.

Productivity improvement suggested by the Productivity Commission

The first scenario used the PC's estimates of spillover effects on multifactor productivity improvement to estimate the benefits. According to the PC (2007), a 1% increase in market-oriented R&D leads to a 0.02% increase in productivity.

This scenario was constructed in these steps:

- Estimate tax forgone (refundable or non-refundable) for each R&D TI participant in 2013–14, following the ATO and R&D TI rules.²³
- Aggregate firm-level R&D expenditure (RDEX) and tax forgone to CIE-REGIONS sectoral RDEX and tax forgone.
- Estimate the induced R&D by applying an additionality rate of 0.5 to the sectoral tax forgone for large firms and a rate of 1.0 to the sectoral tax forgone for SMEs, which leads to an average additionality rate of 0.82 for the whole programme.
- Estimate the percentage increase in total market-oriented R&D by sector caused by the induced R&D. This takes account of the fact that total business R&D (affected by the R&D TI) accounts for only 65% of market-oriented R&D.
- Estimate the sectoral productivity improvement by applying the elasticity of 0.02 (as determined by the PC) to the percentage increase in sectoral market-oriented R&D.

The productivity improvement was sector specific and, on average, the economy-wide productivity improvement associated with the induced R&D from the R&D TI was about 0.16%. This means that for the same amount of inputs Australian GDP in real terms is 0.16% greater with the productivity improvement. Alternatively, this can be thought of as achieving the same level of GDP with 0.16% fewer inputs.

Table 9.1 summarises the assumptions and intermediate calculations leading to the productivity improvement estimate under this scenario.

²³ The tax offset or refund is calculated based on the firm's turnover to determine whether the 40% or 45% offset applies, and taxable income to determine the extent of tax that is offset, refunded or losses carried forward.

Table 9.1 Productivity improvement suggested by the Productivity Commission

Type of firm	Tax forgone	Additionality	Induced R&D expenditure		Spillover elasticity	Productivity improvement
	\$b		\$b	as % of total market R&D		%
Large firms	1.070	0.50	0.535	1.78	0.02	0.04
SMEs	1.881	1.00	1.881	6.27	0.02	0.13
Total	2.951	0.82	2.416	8.05	0.02	0.16

Note: Additionality rates for large firms and SMEs and the spillover elasticity are the key assumptions.

Source: CIE estimates.

Cost reduction scenarios (productivity improvements suggested by survey results)

The second and third scenarios estimated the benefits of the R&D TI scheme by using firms' reported cost reductions that were expected as a result of R&D investment. This was based on information from the survey (Question 30) and used as an estimate of the productivity improvement attributed to the scheme (an alternative to using the PC elasticity estimate in the first scenario). The scenarios were constructed in the same way as the first scenario, except for the last step. Instead of using the PC estimate of elasticity to determine productivity impacts, estimated sectoral cost reductions expected as a result of R&D (from survey data) were used.

The survey responses were not all internally consistent. To address this, the survey data was adjusted so that this relationship was met:

$$\dot{v} = s_c \dot{c} + (1 - s_c) \dot{\pi}$$

where $\dot{v}$, $\dot{c}$ and $\dot{\pi}$ are percentage changes in sales, cost and profit, and s_c is the cost share in total sales. This ensures that the change in revenues expected from the R&D is fully explained by changes in costs and profits.

Firm-level productivity was aggregated to the sectoral level using two alternative weightings: by R&D expenditure and by total production cost. On average, the economy-wide productivity increase associated with the induced R&D from the R&D TI programme was between 0.04% and 0.06%, depending on the weights used.

Unlike the productivity improvement estimated based on the PC findings, which linked the annual productivity improvement to annual growth in R&D, the productivity improvement estimated from the survey data was related to that in the five years after completion of the R&D and could occur in multiple years. This is particularly important in comparing the benefit with costs in the benefit–cost analysis and comparing benefits across scenarios. We discuss the benefit profile for more detail later in this chapter.

Tax cuts

The final two scenarios sought to illustrate the potential benefits that could be realised through an alternative policy—tax cuts up to the same value as the R&D TI. Two forms of tax cut were modelled—a company tax cut and a property tax cut. For the company

tax cut, a universal reduction in the company tax rate was imposed such that the total reduction in tax revenue amounted to \$2.95 billion. The sectoral distribution of this tax cut differed from the benefits distributed through the R&D TI. This is because the benefit, in terms of avoided tax, under the R&D TI varies between sectors based on their R&D intensity, their use of the programme, and the part of the programme accessed (that is, refundable or not). For the modelled property tax rate cut, the cut in tax rates was sector specific and implemented such that the sectoral reduction in the tax equalled the estimated sectoral tax forgone under the R&D TI.

Table 9.2 summarises all the modelled scenarios.

Table 9.2 Benefit scenarios

Scenario	Key assumptions
Productivity	\$2.95 billion tax forgone (benefit to firms); additionality rate of 0.5 for large firms and 1 for SMEs; 0.02% increase in productivity for 1% increase in market-oriented R&D Sectoral-specific productivity improvement as suggested by induced R&D; average productivity improvement is about 0.1%
Cost reduction	\$2.95 billion tax forgone (benefit to firms); additionality rate of 0.5 for large firms and 1 for SMEs; sectoral productivity improvement estimated according to cost reduction answers in the R&D TI survey
Cost reduction: Weighted by RDEX	Sectoral cost reduction estimated using R&D expenditure weighting; average productivity improvement is about 0.6%
Cost reduction: Weighted by total cost	Sectoral cost reduction estimated using production cost; average productivity improvement is about 0.4%
Tax cuts	
Company tax cut	Universal tax rate cut across all sectors such that total tax cut amounts to \$2.95 billion
Property tax cut	Sectoral-specific property tax cut such that total tax cut amounts to \$2.95 billion

Source: The CIE.

For all scenarios, a long-run closure was used. Employment was fixed, and the wage rate adjusted to ensure labour market equilibrium. On the other hand, in the capital market, investment (and thus capital stock) was adjusted to ensure a constant real rate of return to capital.

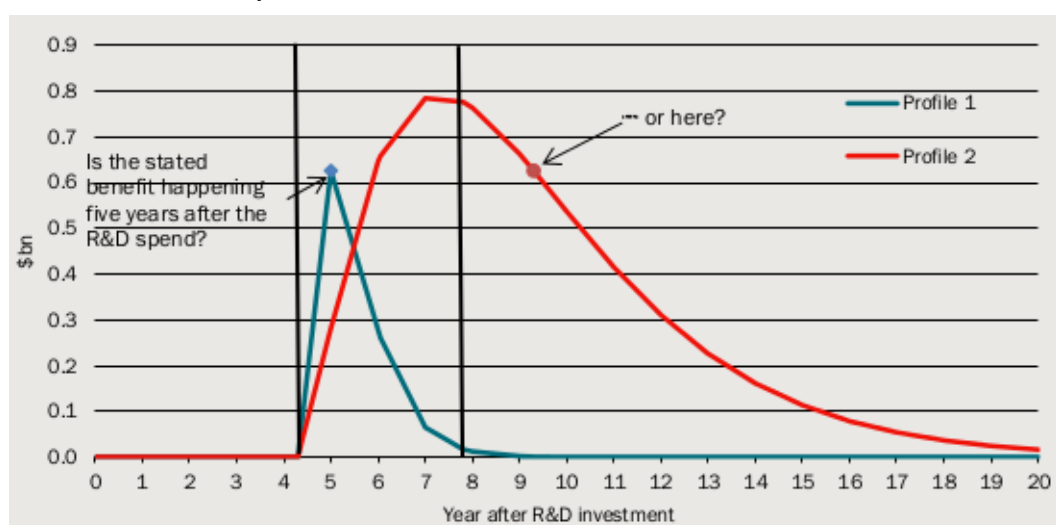
Benefit profile

The PC's estimation of the elasticity of productivity with respect to growth in market-oriented R&D linked an observed annual productivity improvement to annual growth in R&D. This means that the benefits estimated from the economy-wide modelling using the PC productivity assumption (the productivity scenario) can be compared directly with the annual costs (the forgone tax revenue, and associated administrative cost, as well as any distorting cost of raising tax revenue).

On the contrary, there is ambiguity in how to use the benefits estimated under the cost reduction scenarios that were based on the answers to survey Question 30. The question asked respondents for the potential impacts of their R&D in a typical year, five years after completion of the R&D. In other words, this question provided a snapshot of annual impacts of typical R&D, and did not specify how the impacts would evolve.

Answers to other questions (27 and 31) could be used to hypothesise the annual benefit profile. Chart 9.3 illustrates two different potential profiles of benefit derived from the cost reduction scenarios as described in Table 9.2 and represents the two possible extremes.

Chart 9.3 Illustrative profile of benefits



Data source: CIE calculation.

The horizontal axis denotes the number of years after the start of an R&D project. According to the R&D TI survey, the average project would be commercialised after 4.3 years (marked by the first vertical line), and on average competitors would catch up 3.5 years after commercialisation (marked by the second vertical line). No benefits would be expected until the completion of commercialisation stage. The difference between the two benefit profiles arises from how we interpret the timing of the cost reduction indicated by the survey respondents and how we define the benefits when competitors catch up.

Profile 1 assumes that:

- the stated cost reduction happens 5 years after the start of a typical R&D project
- at the time competitors catch up, the benefits to the investing firm have been eroded.

This is illustrated by the blue line for Profile 1 in Chart 9.3.

It is also possible that the stated cost reduction happens 5 years after the completion of commercialisation (that is, 9.3 years after the start of the R&D project). The time at which competitors catch up may reflect falling (but still positive) benefits. The remainder of the benefits are eroded over time. This is illustrated by the red line in the chart (Profile 2).

The total value of the benefit from a single year of R&D investment is represented by the area under the benefit profile curve (or the present value of the benefits over the full period).

These two profiles present two extremes of the likely situation, with Profile 1 being the lower bound and Profile 2 the upper bound. The real situation would lie in between the two extremes.

Modelling results

Table 9.4 summarises the results from the different scenarios. The second and third columns report the annual increase in GDP and household consumption, while the fourth column is the present value of benefits (measured by household consumption change), taking into consideration the benefit profile as illustrated in Chart 9.3 and a discount rate of 7%.

In CGE modelling literature, change in GDP is a measure of overall economic activity, while change in household consumption is used as a measure of welfare change.²⁴

Table 9.4 Increase in GDP and consumption

Scenario	Annual impact		Present value of benefits ^a
	GDP	Consumption	
	\$b	\$b	\$b
Productivity improvement	3.66	1.83	1.83
Cost reduction			
Weighted by RDEX—Profile 1	1.84	0.99	0.99
Weighted by RDEX—Profile 2	1.84	0.99	4.53
Weighted by total cost—Profile 1	1.17	0.63	0.63
Weighted by total cost—Profile 2	1.17	0.63	2.87
Tax cuts			
Company tax cut	1.66	3.52	3.52
Property tax cut	4.09	4.98	4.98

^a Present value of changes in household consumption, using the benefit profile illustrated in Chart 9.3 and a discount rate of 7%.

Note: 2013–14 dollars.

Source: CIE-REGIONS simulations.

There were two main mechanisms in play to explain the different patterns in results for these scenarios. For the productivity improvement and cost reduction scenarios, Australian products became more competitive in the world market, leading to export growth. That is, the increase in Australian production (GDP) was greater than the increase in Australian household consumption. By contrast, the tax cut scenarios

²⁴ Consumption is an indicator of welfare and is measured in real terms; in that sense, it accounts for changes in the volume and quality of goods and services consumed.

increased household income, which boosted household consumption and depressed export growth. As a result, household consumption increased by more than GDP.

The productivity scenario (see Table 9.2) simulation suggested that the \$2.95 billion spending on the R&D TI leads to welfare gains of \$1.8 billion, while the cost reduction scenario simulations revealed annualised welfare gains of between \$0.6 billion and \$4.5 billion. The tax cuts simulations gave welfare gains of \$3.5 billion for the company tax cut and \$5.0 billion for the property tax cut.

10 Costs of the programme

Compliance costs to firms incurred to register for and claim the R&D TI are estimated to be around 9% of the benefits they receive in offset or refunded taxes. A significant share of this (around 46%) is paid to consultants.

Administrative costs to the government to administer the programme, including compliance activities, are reported to be up to \$28 million per year.

The forgone tax revenue (including tax offsets and refunds) under the programme was \$2.95 billion in 2013–14. The forgone tax revenue is effectively a transfer of funds from one party (the taxpayer or government) to another (the R&D TI recipient) and was therefore not included as a cost in our benefit–cost analysis.

The deadweight loss of tax is assumed to be 0.19 per dollar of tax raised. Both the forgone tax revenue and the administrative costs incurred by the government impose a deadweight loss on the economy.

Administrative and compliance costs

Compliance costs to firms

Compliance costs are incurred by the firm in time and resources taken to complete the registration process, complete the R&D schedule in the tax return, maintain the necessary records to demonstrate and justify the activities and expenses, and respond to reviews and audits by AusIndustry and the ATO. In many cases, firms engage consultants to do all or some of this work.

In our consultations, estimates of the compliance costs (relative to the benefit received) ranged from 5% up to 30%. The survey also included a question about the compliance cost of participating in the programme. Table 10.1 summarises the responses to this survey question. Based on the responses, the compliance cost relative to the benefit received is estimated at around 9%.

The survey responses also allowed a comparison of compliance costs between those firms that used consultants and those that did not. The use of a consultant appears to significantly increase the compliance cost to the firm, but there are a number of caveats to that finding:

- Consultants provide more services than simply performing the administrative tasks required under the R&D TI. Many also provide broader research advice, including on

how, where and when to undertake research. Some of the costs reported through the survey are likely to incorporate those services.

- Despite the question's specification that the reported costs should be associated with the R&D TI, there was still some possibility that the costs incorporated the costs of managing other tax affairs.
- The number of firms that did not report consultant costs through the survey was small, which means that the results of a comparison between these groups might not be statistically significant.

Table 10.1 Survey responses on compliance costs (\$ per firm)

Cost item	unit	All firms (weighted average)	Large firms	SMEs
Application and registration	\$	13,784	49,599	9,503
R&D schedule of tax return	\$	11,554	27,354	9,665
Record keeping	\$	10,120	37,171	6,887
Other	\$	1,396	3,748	1,115
Total compliance costs (95% confidence interval)	\$	36,854 (25,730 to 47,980)	117,872 (78,860 to 156,885)	27,170 (19,380 to 34,962)
Total compliance cost as a share of benefits	%	9	8	23
Paid to a consultant	\$	16,797	63,334	11,233
Share paid to a consultant	%	46	54	41

Source: R&D TI survey 2015.

The weighted average compliance cost based on survey responses indicated that the total compliance cost to all firms in the programme was around \$437 million and that the fees paid to consultants totalled around \$199 million.

Administrative costs to the government

Funding for running costs to administer and deliver the R&D TI is allocated through normal government budget processes as departmental and administered appropriations to the department and the ATO.

Departmental appropriations are used for costs internal to the department (predominantly staff salaries and associated overheads) and include allocations for policy and corporate functions. Administered funds are allocated for external costs, such as legal services, communications and information technology systems.

Government costs associated with the R&D TI are outlined in Table 10.2.

Table 10.2 Government administrative costs, typical year (\$'000)

Cost item	Funding	Data source
Administered funding: AusIndustry	2,823	Portfolio Budget Statements 2014–15, Budget Related Paper no. 1.12, Industry Portfolio
Departmental funding: ATO	5,800–8,700	ATO, pers. comm.
Departmental funding: DIIS	13,432	DIIS, pers. comm.
Total administrative costs	22,055–24,955	–

ATO = Australian Taxation Office; DIIS = Department of Industry, Innovation and Science.

Note: Estimates of forgone revenue and refunds are included in the next section. These costs are based on costs for 2014–15, as they are thought to be the most reliable estimates of costs to run the programme in a typical year.

Forgone tax revenue

According to the Science, Research and Innovation Portfolio Budget tables, the R&D TI cost a total of \$2.951 billion in 2013–14 in forgone tax and refunded tax offsets. Of that, \$1.070 billion was attributed to the non-refundable portion of the programme and \$1.881 billion to the refundable portion (Table 10.3).

The forgone tax revenue is effectively a transfer of funds from one party (the taxpayer or government) to another (the R&D TI recipient). The accepted approach to benefit–cost analysis is to not include transfers in the benefit–cost analysis as they are not a resource cost. As this is a cost to government but a benefit to firms, the amounts effectively cancel each other out in the benefit–cost or net present value calculations. We need to understand the amount of forgone tax, however, to estimate the deadweight loss associated with the R&D TI. It is also relevant in considering alternative ways of funding research initiatives.

Table 10.3 Forgone tax revenue and refunded tax offsets (\$ million)

Programme / activity	2011–12	2012–13	2013–14	Estimated actual 2014–15	Budget estimate 2015–16
Non-refundable	1,080	1,120	1,070	980	960
Refundable	1,454	1,418	1,881	2,040	1,969
Total	2,534	2,538	2,951	3,020	2,929

Note: Costs are actual costs in the year incurred.

Source: 2015–16 Science, Research and Innovation Portfolio Budget tables.

The cost of the programme (in forgone tax and refunds) increased from \$2.534 billion in 2011–12 and \$2.538 billion in 2012–13 to \$2.951 billion in 2013–14. Costs are expected to continue to increase. Future increases in the costs of the programme may be due to increased R&D expenditure by firms, an increase in the number of firms using the programme, or both. The cost of the programme would also increase as the proportion of small firms (and in particular, small loss-making firms) increases.

An analysis of programme data by AusIndustry suggests that there has been a decrease in average R&D expenditure per registration under the programme compared to the R&D Tax Concession. This may have been due to the tightening of the definition of R&D activities from the one used for the R&D Tax Concession. However, the reduction in

average project value has been outweighed by a larger than expected increase in the number of entities that use the R&D TI, particularly SMEs, attracted by higher rates of assistance and an offset as opposed to a deduction offered under the R&D Tax Concession.

Deadweight loss of tax

The main taxes used to raise government revenue distort price signals and thereby change the behaviours of individuals, firms and investors. This leads to losses in economic efficiency (called the excess burden of taxation or the deadweight loss of tax). The extent of this lost efficiency differs according to the tax instrument used.

Many approaches are used in the published tax literature to estimate the marginal excess burden and economic incidence of taxation. The Treasury (Cao et al. 2015) published a range of marginal excess burden (or deadweight loss) estimates. Cao et al. found that raising the rate of an existing tax by an amount sufficient to generate \$1.00 of additional net revenue would impose a cost on the economy of between –\$0.10 and \$0.72. The marginal excess burden for the company tax rate was estimated to be \$0.50.

In our own analysis, we used the results of the company tax cut simulation as an indication of the excess burden or deadweight loss of company tax. That simulation indicated that the welfare loss would be \$3.52 billion to raise company tax of \$2.95 billion, implying that the excess burden of company tax is around 0.19.²⁵ Our assumption is therefore lower than the burden estimated by the Treasury for the company tax rate and at the lower end of the range of the different taxes considered by the Treasury.

Both the forgone tax revenue and the administrative costs incurred by the government impose a deadweight loss on the economy.

²⁵ The excess burden is calculated by dividing the net welfare loss (\$3.52 billion minus \$2.95 billion) by the total amount of tax (\$2.95 billion).

11 Benefit–cost analysis

Based on the central estimate of the additionality rate (0.82) and the range of benefit profiles estimated, the annualised present value of net benefits (benefits minus costs) of the programme could vary from –\$0.4 billion to +\$3.5 billion, and the benefit–cost ratio from 0.6 to 4.4. The benefit–cost ratio for small firms is greater (0.7 to 5.2). The results are highly sensitive to the additionality rate and spillover effects assumed.

There is significant value in increasing the average additionality rate under the programme (\$77 million to \$566 million for every 0.1 increase in the additionality rate).

The estimated benefits of the R&D TI could be compared with potential alternative uses of the tax revenue—such as other research programmes or general tax cuts—which would require higher additionality and spillover rates than break-even but which are possible within the identified range of rates.

Benefit–cost analysis results

Here we combine the discussions on benefits and costs of the R&D TI programme and present the results of a formal benefit–cost analysis.

Chart 11.1 shows the present value of net benefits (NPV, or benefits minus cost, left panel) and the benefit–cost ratio (BCR, right panel), assuming an additionality rate of 0.82, an excess burden of 0.19 and alternative benefit profiles for all firms.

The various elements included in these calculations are summarised in Table 11.2. In Table 11.2 the total costs, net present value and BCR are calculated, treating forgone revenue as a transfer (that is, excluding the forgone revenue).

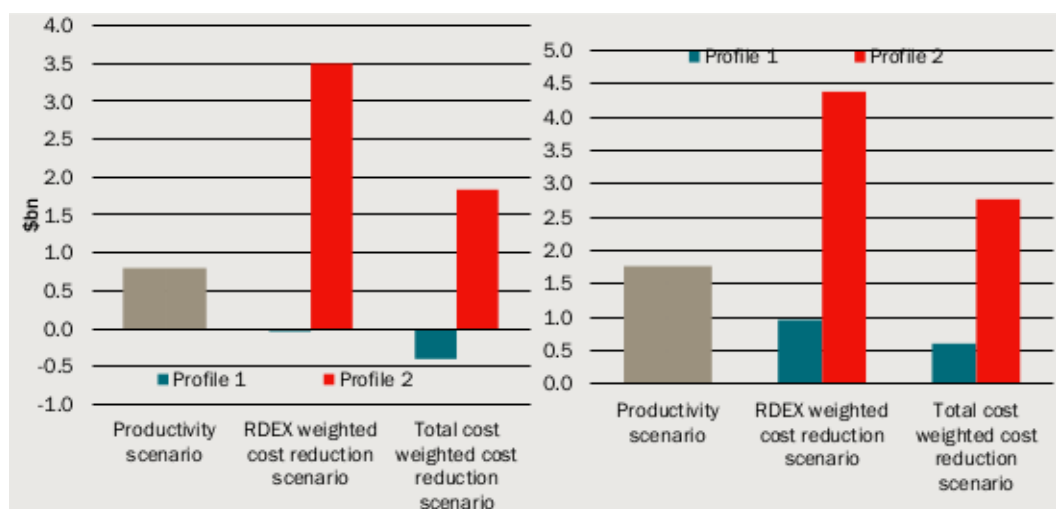
It can be seen from the chart and the table that the different assumptions of the benefits lead to different results: the annualised present value of net benefits (benefits minus costs) of the programme could vary from –\$0.4 billion to +\$3.5 billion, and the BCR from 0.6 to 4.4.

Tables 11.3 and 11.4 report the benefit–cost analysis for large and SMEs, respectively, in the same way as Table 11.2 for all firms.

For the purposes of the benefit–cost analysis, government administrative costs were allocated between large firms and SMEs based on the share of forgone (or refunded) tax. This was a simple assumption for the purposes of illustrating the relative BCRs for SMEs and large firms. A more accurate split of administrative costs will not materially affect the ratios.

It is evident from Tables 11.3 and 11.4 that SMEs have higher net benefits and BCRs than large firms. This is due to two factors: SMEs receive more support from the government, as measured by the forgone tax revenue (\$1.88 billion to SMEs versus \$1.07 billion to large firms); and higher additional R&D induced by the support (an additionality rate of 1 assumed for SMEs versus 0.5 for large firms).

Chart 11.1 Net present value and benefit–cost ratio



Note: Assuming additionality rate of 0.82, excess burden of 0.19.

Data source: CIE calculation.

Table 11.2 Calculation of benefit–cost ratio—all firms

Scenario	Benefits	Costs				Total economic cost	Present value of net benefits	Benefit–cost ratio
	Present value of spillover benefit	Forgone tax revenue	Government administrative cost	Compliance cost	Deadweight loss			
	\$b	\$b	\$b	\$b	\$b	\$b	\$b	–
Productivity scenario	1.83	2.95	0.02	0.44	0.57	1.03	0.80	1.77
RDEX-weighted cost reduction scenario								
Benefit profile 1	0.99	2.95	0.02	0.44	0.57	1.03	–0.04	0.96
Benefit profile 2	4.53	2.95	0.02	0.44	0.57	1.03	3.50	4.38
Total cost-weighted cost reduction scenario								
Benefit profile 1	0.63	2.95	0.02	0.44	0.57	1.03	–0.41	0.61
Benefit profile 2	2.87	2.95	0.02	0.44	0.57	1.03	1.83	2.77

Note: Assuming additionality rate of 0.82, excess burden of 0.19.

Source: CIE calculations.

Table 11.3 Calculation of benefit–cost ratio—large firms

Scenario	Benefits	Costs				Total economic cost	Present value of net benefits	Benefit–cost ratio
	Present value of spillover benefit	Forgone tax revenue	Government administrative cost	Compliance cost	Deadweight loss			
	\$b	\$b	\$b	\$b	\$b	\$b	\$b	
Productivity scenario	0.41	1.07	0.01	0.15	0.21	0.37	0.04	1.11
RDEX-weighted cost reduction scenario								
Benefit profile 1	0.24	1.07	0.01	0.15	0.21	0.37	–0.13	0.64
Benefit profile 2	1.07	1.07	0.01	0.15	0.21	0.37	0.71	2.94
Total cost-weighted cost reduction scenario								
Benefit profile 1	0.15	1.07	0.01	0.15	0.21	0.37	–0.21	0.42
Benefit profile 2	0.70	1.07	0.01	0.15	0.21	0.37	0.33	1.91

Note: Assuming additionality rate of 0.5 for large firms, excess burden of 0.19

Source: CIE calculations.

Table 11.4 Calculation of benefit–cost ratio—SMEs

Scenario	Benefits	Costs				Total economic cost	Present value of net benefits	Benefit–cost ratio
	Present value of spillover benefit	Forgone tax revenue	Government administrative cost	Compliance cost	Deadweight loss			
	\$b	\$b	\$b	\$b	\$b	\$b	\$b	–
Productivity scenario	1.43	1.88	0.01	0.29	0.37	0.67	0.76	2.13
RDEX-weighted cost reduction scenario								
Benefit profile 1	0.76	1.88	0.01	0.29	0.37	0.67	0.09	1.14
Benefit profile 2	3.46	1.88	0.01	0.29	0.37	0.67	2.79	5.17
Total cost-weighted cost reduction scenario								
Benefit profile 1	0.48	1.88	0.01	0.29	0.37	0.67	–0.19	0.71
Benefit profile 2	2.17	1.88	0.01	0.29	0.37	0.67	1.50	3.24

Note: Assuming additionality rate of 1 for SMEs, excess burden of 0.19.

Source: CIE calculations.

Sensitivity analysis

Additionality and spillovers

Two key assumptions were made in the benefit–cost analysis :

- The additionality rate for large firms is 0.5 and for SMEs is 1 (giving an average rate of 0.82).
- The spillovers arising from the additional research align to the five selected scenarios (which are equivalent to assuming that the elasticity of productivity for R&D expenditure ranges from 0.006 to 0.05).

Each of these metrics is extremely difficult to measure, so the assumed values are highly uncertain. Here we discuss the impact of varying these key assumptions.

Revenue cost of the scheme

Some concerns have been raised among the public that the government’s estimate of the cost of the scheme (in terms of refunded or offset tax revenue) is overstated (see, for example, Loussikian 2016).

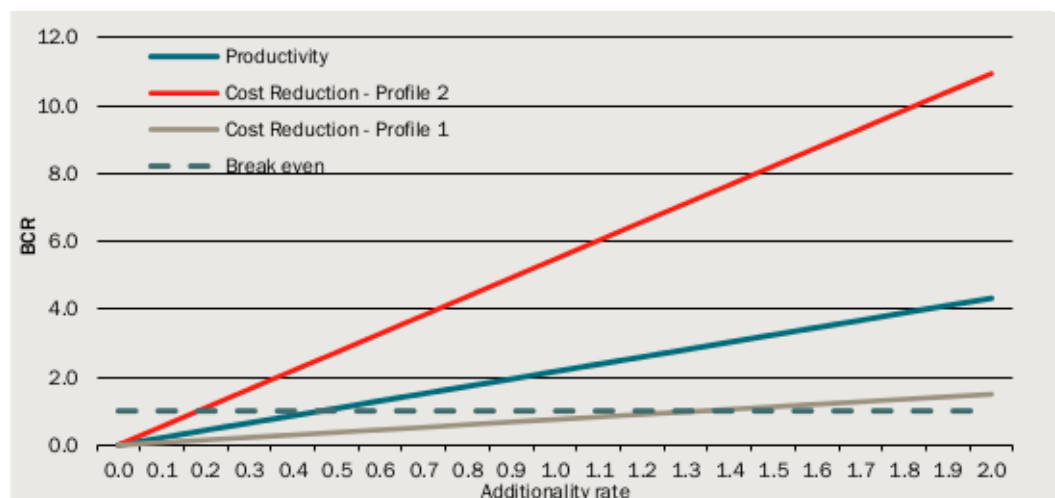
A lower amount of forgone tax revenue implies a lower subsidy to recipients, which will lower both the benefits (determined by the additionality and spillover rates) and the costs (through the deadweight loss of taxation) of the programme. At the same time, the compliance and administration costs remain the same.

For example, a reduction in tax foregone from \$2.95 billion to \$2.2 billion (reflecting a suggested cost reduction of \$750 million) has the effect of lowering the BCRs presented in Table 11.2. Instead of a range from 0.61 to 4.37, this would become a range from 0.53 to 3.80.

Impact of the additionality rate on benefit–cost ratios

Chart 11.5 shows the impact on BCRs of varying the additionality rate for the three selected scenarios, using assumptions of an excess burden of 0.19 and a discount rate of 7%.

Chart 11.5 Sensitivity analysis of additionality and spillovers



Note: Assuming excess burden of 0.19, discount rate of 7%.

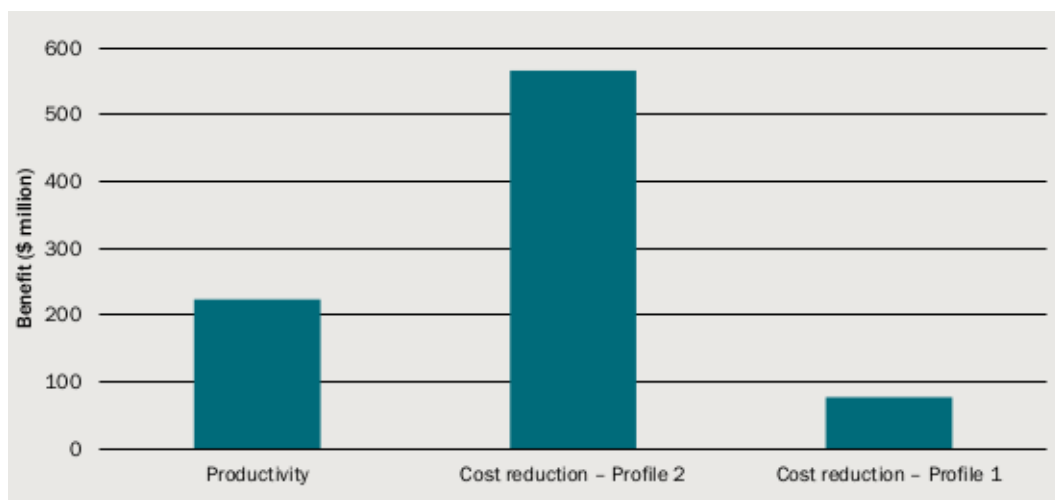
Data source: CIE calculation.

The blue dashed line shows the break-even position where the present value of benefits equals the present value of costs. Any points above the break-even line (that is, BCRs above 1) indicate that the benefits from the programme would be more than the cost, while for those below the break-even line costs would be greater.

It can be seen that for the cost reduction (Profile 2) scenario, the programme would be worthwhile when the additionality rate is 0.18 or above. For the productivity scenario, the required additionality rate for break-even would be higher, at around 0.46. For the cost reduction (Profile 1) scenario, the required additionality rate would be much higher at around 1.33.

Value of increasing the average additionality rate

Chart 11.6 shows the change in the value of benefits when the average additionality rate was increased by 0.1 under the three scenarios. With the current level of R&D expenditure, every 0.1 increase in the additionality rate would lead to an increase in annual benefits ranging from \$77.6 million to \$566 million (depending on the scenario).

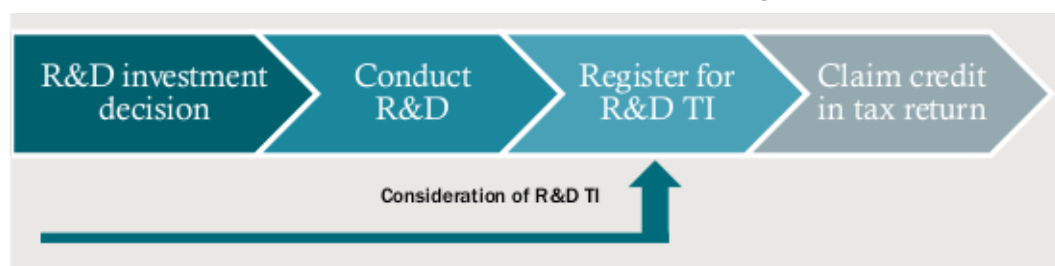
Chart 11.6 Increase in benefit from increase in additionality rate by 0.1

Note: Assuming discount rate of 7% and tax foregone under the R&D TI Programme of \$2.95 billion.

Data source: CIE calculation.

Changing the timing of the programme to increase additionality rates

Under the current arrangements for the R&D TI, firms are faced with the decision process outlined in Chart 11.7. Under this approach, firms start to include the R&D TI in their decision-making process at any point until the deadline for registration (10 months after the end of the income year in which the R&D was conducted).

Chart 11.7 Decision process under the R&D Tax Incentive programme

Source: The CIE.

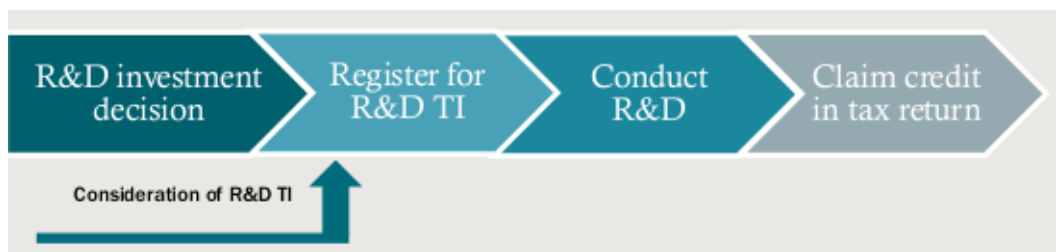
In our consultations, stakeholders explained that, in some cases, registration for the R&D TI was indeed not considered until after R&D had been conducted. Based on the survey results, around one-quarter of firms said that the R&D TI was not considered in making decisions about R&D investments.

The implication of this is that the cost to government in refunded or offset tax for these firms is not leading to additional R&D. All the tax that these firms avoid is effectively a direct transfer of funds from the taxpayer to the firm (via the government).

An alternative application process with earlier registration of projects is likely to increase the consideration of the R&D TI in firms' decision-making and may reduce the likelihood of firms claiming the R&D TI for non-additional R&D. If a firm is required to register an R&D project before undertaking the R&D, or during the early stages as

illustrated in Chart 11.8, the R&D TI is likely to have a greater impact on R&D undertaken in Australia (relative to the amount of forgone or refunded tax revenue).

Chart 11.8 Decision process—pre-registration



Source: The CIE.

This type of approach has been adopted in Norway (see Box 11.1). An evaluation of the Norwegian tax credit shows strong participation by small firms and high additionality rates. Firms with fewer than 50 employees undertook around 85% of approved projects and accounted for 45% of expenditure. The estimated additionality rates ranged from 1.3 to 2.9, with a best guess of around 2 (Hægeland and Møen 2007).

In data collected through the programme, 12% of Norwegian firms reported that they would undertake the R&D without the tax credit (Hægeland and Møen 2007). This compares with around 65% of firms receiving the R&D TI that stated that the incentive did not affect the decision to do the R&D.

Box 11.1 SkatteFUNN: Norway's tax credit programme

In Norway, the 2,000 recipients of the SkatteFUNN tax credit are required to register their R&D projects before the end of the tax year in which the R&D is conducted. For each project, firms lodge an application that sets out the objective and the scope of the project, which should be clearly distinguishable from normal operating activities. A project application may span work to be conducted over several years.

Once the relevant authority assesses and approves the project, the firm is able to receive a tax credit for the expenses associated with the project incurred in the year the application is approved and subsequent years as set out in the application. Firms submit a report each year (and at the end of the project), which provides the authority with valuable information on the use and outcomes of the programme and has been used in the evaluation of the programme.

There is flexibility within the process to allow for project delays, the early termination of a project and changes in budget and expenditure over the course of the project.

Shifting the timing of the application process under the R&D TI scheme would lead to some adjustment costs and, as with any change to the programme, may have negative implications by creating uncertainty and instability. However, a shift in timing is unlikely to significantly increase the compliance burden on firms, as the same processes (AusIndustry registration and tax claims with the ATO) are required. Shifting the timing of registration would not require a full assessment approach, as used in Norway; a self-assessment approach would remain feasible. The change could, *prima facie*, increase

additionality and lower the tax forgone. Firms may also benefit from the discipline of setting out research objectives and goals before undertaking R&D projects.

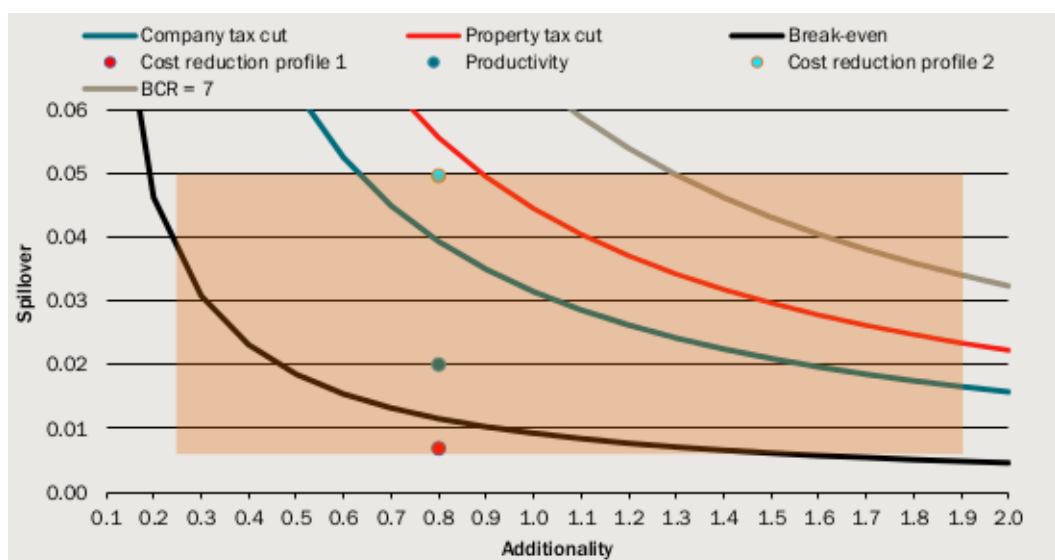
Impact of additionality and spillovers on net benefits

Previous discussions show that results of the benefit–cost analysis are highly dependent on the assumption of key variables, especially the additionality rate and the spillover effect parameter. To see how the results were affected by the assumed values, we conducted sensitivity analysis by varying the additionality rate from 0 to 2 and varying the spillover effect parameter (the elasticity of productivity for R&D expenditure) from 0 to 0.06.

The curves plotted in Chart 11.9 show the combinations of these two parameters that achieved the same value of benefits (isovalue curves). The four isovalue curves represent break-even (black line), benefits equivalent to a company tax cut (blue line), benefits equivalent to a property tax cut (red line) and benefits equivalent to realising a BCR of 7:1 (grey line).

The black curve represents all the combinations of the additionality rate and the spillover effect parameter that generate benefits that are equal to costs (excluding the transfer of \$2.95 billion). Combinations of parameters that lie above the curve (to the top right) would generate benefits higher than the cost, while those below the curve would generate benefits lower than the cost.

Chart 11.9 Isovalue curves of benefit and required additionality rate and spillover elasticity



Note: Assuming discount rate of 7%.

Data source: CIE calculation.

The shaded rectangle represents the likely range of the two parameters based on our analysis and consistent with the literature. PC (2007) estimated the spillover parameter at between 0.01 and 0.05, which is broadly consistent with the range of spillover rates

implied by our scenarios. Our estimate of the additionality rate ranges from 0.3 to 1.5, and Thompson and Skali (2016) estimated a rate between 0.8 and 1.9.

It can be seen that it is likely that the R&D TI programme would achieve net benefits greater than zero (or a BCR greater than 1:1), as a large share of the parameter combinations are above the break-even curve. However, fewer parameter combinations lie above the other lines, indicating that it is less likely that the programme would achieve benefits as great as tax cuts.

The three dots in the chart denote the benefits under the three scenarios discussed. The bottom red dot denotes Benefit profile 1 of the cost reduction scenario weighted by total cost, the top blue dot Benefit profile 2 of the cost reduction scenario weighted by R&D expenditure, and the middle green dot the productivity scenario. These three cases use the same assumption about the additionality rate (0.82), but represent alternative estimates of the value of spillovers.

Opportunity cost of the forgone tax revenue

The analysis essentially compares the benefits of the R&D TI in terms of spillovers with the cost of raising the tax (deadweight loss) and the administrative costs associated with the programme. What the analysis does not consider is the value of alternative uses of the funds, such as for other R&D-focused activities or more generic applications.

The PC examined the returns to a range of R&D projects and found the median BCR on research projects in Australia to be around 7:1, and that ratios ranged from zero into the hundreds (PC 2007). This indicates that, on average, alternative research programmes to the R&D TI could generate returns greater than the central estimates from this evaluation (BCRs of between 0.6 and 4.4).

The combinations of additionality rates and spillovers that would be needed to achieve equivalent benefits from the R&D TI are shown by the grey line in Chart 11.9. This demonstrates that, for the range of spillover effect parameters discussed in the literature, the additionality rate would need to be greater than 1.3 in order to achieve a BCR similar to those for median research projects.

Alternatively, the tax raised to fund the R&D TI could be returned to taxpayers through reductions in tax rates. Two examples that have been examined in this evaluation are a change in corporate tax rates and changes in property taxes. By lowering tax rates, the deadweight loss (or excess burden) of taxation is reduced and taxpayers have the opportunity to invest this money to maximise their rate of return.

Chart 11.9 illustrates the R&D TI parameters that would lead to benefits equivalent to the tax cuts. Benefits equivalent to the corporate tax cut would mean the BCR of the R&D TI would need to be 3.4:1; the equivalent figure for the property tax cut is 4.8:1.

Tax cuts and the R&D TI are clearly very different policies. The purpose of this comparison is simply to provide an alternative benchmark for the level of BCR that would be reasonable for the R&D TI.

12 Conclusions

The R&D TI is a significant government programme that is highly valued by its recipients and is consistent with much international practice in government support for business R&D. In principle, it aligns well with government objectives to increase innovation.

A key challenge for the R&D TI is that the magnitude of its impacts on the economy depends on factors that are largely outside of programme control. These key factors—additionality and spillovers—are also difficult to evaluate empirically. This means that the overall impacts of the programme are subject to considerable uncertainty.

Key findings

Rationale

There is general in-principle agreement that because of the spillovers (wider economic benefits) associated with business R&D there is a case for government measures to attempt to induce *additional R&D* (that is, R&D that would not have otherwise taken place) in order to achieve a greater level of spillover.

It is widely agreed that, because of the nature of knowledge spillovers and the potential for underinvestment in R&D, it is appropriate for the government to use instruments to encourage additional R&D that will subsequently result in additional spillovers.

It is also generally agreed that R&D spending responds to changes in the cost of undertaking R&D; lowering R&D costs will, all other things being equal, lead to additional R&D, compared with what would otherwise have been the case.

Further, it is widely agreed that tax incentives in the form of tax offsets for expenditure on R&D have the effect of lowering R&D costs, which should induce additional R&D.

What is uncertain is the exact extent to which a dollar of tax incentive (that is, a dollar of tax forgone from the government's perspective) will lead to incremental R&D by firms when compared with business as usual. Will it result in a dollar's worth of incremental R&D, or more or less than that amount?

In addition, the incentive by itself cannot guarantee the value of spillovers associated with the incremental R&D. Can the use of the taxation system to transfer resources from taxpayers to firms conducting R&D generate net social benefits compared with alternative uses of those tax resources?

These specific empirical questions need to be addressed to consider whether the incentive can meet its objectives cost-effectively.

Underlying trade-offs

While there is some debate about the exact form these measures should take, there is also agreement that the use of the tax system is appropriate as a component of strategies to generate wide benefits from R&D.

At the same time, there is a general understanding that the practical application of tax policies designed to induce additional R&D is subject to a number of trade-offs and constraints. There is broad agreement on general principles of best practice when using the tax system in this way.

The use of the tax system to encourage additional R&D involves a number of trade-offs:

- On the one hand, a tax-based instrument takes advantage of the taxation infrastructure already in place by using monitoring and compliance systems that are broadly familiar to most firms.
- Similarly, using the tax system allows for effective R&D subsidies that are neutral with respect to the nature of the firm involved, the nature of the R&D involved, and the size of the firm (aside from the non-neutral elements deliberately introduced into the R&D TI).
- On the other hand, the tax system is a very blunt instrument with which to achieve either additionality or spillovers from research. ‘Blunt’ in this sense means that the system has limited ability to control or target additionality or spillovers. Indeed, the rates of additionality and spillover are largely determined by factors outside the R&D TI.
- Further, in the course of consultations we observed that the use of the tax system results in a strong tendency to view the R&D TI as a ‘tax measure’ rather than as an ‘R&D measure’.
- As configured in Australia, the R&D TI applies to all R&D, whether or not it is truly additional. It is a ‘volume’-based scheme rather than an ‘incremental’ scheme. This means that the incentive is unable to target additional R&D. However, international experience suggests that attempts to focus on ‘incremental’ R&D only introduce undesirable distortions into R&D decisions.
- Similarly, the R&D TI does not contain any particular instruments to ensure maximum spillovers, aside from an initial threshold of ensuring that the R&D expenditure claimed is for genuine R&D.

Empirical uncertainties

The general literature acknowledges that it is hard to measure the impact of policies such as the R&D TI. Internationally, a full benefit–cost analysis of similar programmes has taken place in only a few cases.

Benefits emerging from the programme depend crucially on additionality and spillovers. Both are hard to measure.

The two most crucial elements of the R&D TI (additionality and spillovers) turn out to be extremely difficult to empirically measure and evaluate.

Additionality cannot be directly measured and must be inferred through interviews, surveys and statistical analysis, and modelling. Therefore, estimates of additionality will always be imprecise and subject to uncertainty. In the analysis presented here, we have tried to be very explicit about this uncertainty, using statistical and modelling techniques to provide a range of estimates.

Spillovers, while in principle evident from the techniques of growth accounting, have also proved to be extremely difficult to measure empirically. At one extreme, it is understood that spillovers are likely to be quite large: Baumol (2010) estimated that the spillover rate in the US may be as high as 90%. Precise estimates using focused Australian data have proved more elusive.

Despite the R&D TI's theoretical credentials and the popularity of tax incentives around the world, the effects of this policy will always remain unclear while these empirical uncertainties remain.

Additionality

International literature suggests that additionality (defined as the dollar increase in R&D per dollar of incentive provided) is around 1. The empirical estimates presented in this report suggest a range from 0.3 to 1.5. Separate empirical research commissioned by the department suggests a value between 0.8 and 1.9.

This report reviews a range of evidence on additionality, including by reviewing the literature, survey results and the latest results of econometric analysis. For convenience, we define additionality as the dollar increase in R&D spending for each dollar of tax incentive provided:

- Most international studies suggest a value around or slightly less than 1. In the international literature, there is general scepticism about numbers significantly greater than 1.
- Detailed analysis of our survey results, using both 'stated' outcomes (what the firms told us when we asked directly) and modelled outcomes (using the survey results to calibrate an economic model of R&D), suggests overall additionality of between 0.3 and 1.5 (the higher rate is for SMEs only).
- Our estimates (based on detailed survey results) suggest that additionality is statistically significantly higher for SMEs than for large firms.
- Separate econometric work commissioned by the department, which compares R&D undertaken by firms receiving the R&D TI with R&D undertaken by a control group that does not receive the R&D TI, suggests an additionality rate in the range of 0.8 to 1.9.
- Discussions during our consultations, and in interviews with individual firms, were consistent with these overall results.

Additionality and SMEs

Our empirical estimates consistently suggest higher additionality for small firms compared with large firms. This is also consistent with most of the international literature. In our analysis for Australia, this difference remains even when the threshold for small versus large is varied.

A similar range of evidence consistently suggests much higher additionality rates for small firms versus large firms:

- Results from our survey, under all alternative approaches, suggest that SME additionality is between 2 and 3 times higher than that for large firms.
- There is also compelling evidence from consultations and interviews that small start-ups, particularly in the research-focused biological and medical areas that receive a cash refund from the offset, rely on it to be able to continue their research. In their case, additionality is relatively high.

Spillovers

Spillovers are similarly hard to estimate. The analysis presented here follows the work of the PC and focuses on the link between R&D and productivity. Our empirical estimates are consistent with the range suggested by the PC. As the PC also noted, it is not possible to provide definitive estimates of spillovers.

Evidence on spillovers is considerably harder to gather. There is limited information in the international literature, and some of the best work in this area remains that undertaken by the PC (2007) in its *Public support for science and innovation* report.

- A recent Australian study (Elnasri and Fox 2014) looking at using intangible capital within a growth accounting framework found no evidence of spillovers from induced business R&D, along with very strong evidence of spillovers from other forms of R&D.
- In our survey results, we note that on average 56% of R&D spending is targeted at new products or processes. This breaks down into 67% for small firms and 55% for large firms. To the extent that there are more spillovers associated with new products, these results suggest higher (marginal) spillovers from small firms.
- Considering other outcomes from R&D, the survey results suggest that 32% of R&D results in products or processes new to Australia (31% for large firms and 59% for small firms). Again, this suggests higher (marginal) spillovers from small firms (to the extent that novelty is associated with higher spillovers).
- Further, the survey suggested that 24% of R&D results in products or process new to the world. This was 24% for large firms and 46% for small firms, consistent with other survey results.

Compliance and administration costs

Our empirical research suggests that the compliance costs of the programme are around \$37,000 per firm. This is approximately 9% of the tax benefit received.

Programme administration costs are estimated at up to \$28 million per year, or approximately 1% of the benefits provided to firms.

More broadly, we identified no major concerns about programme administration.

Benefit–cost analysis

Based on our central estimate of the additionality rate (0.82) and a range of benefit profiles estimated based on survey results, the annualised present value of net benefits (benefits minus costs) of the programme varies between –\$0.4 billion and +\$3.5 billion, and the benefit–cost ratio from 0.6:1 to 4.4:1. The benefit–cost ratio for small firms is greater (0.7 to 5.2).

However, the results are highly sensitive to the additionality rate and spillover effects assumed:

- Based on the range of parameter values for additionality and spillovers identified in this evaluation, the programme is likely to realise a benefit–cost ratio greater than 1.
- The estimated benefits of the R&D TI could be compared with potential alternative uses of the tax revenue, such as for other research programmes or tax cuts involving revenue costs equivalent to those of the R&D TI.
- The required benefit–cost ratio to be equivalent to tax cuts would be in the range of 3:1 to 5:1, which is achievable, but probably difficult for the R&D TI.
- Benefit–cost ratios achieved through other research programmes have been estimated to be around 7:1. For the R&D TI to lead to a ratio comparable to those alternatives, the additionality rate and spillover effects would need to be at the highest end of the ranges estimated in the empirical literature.

These benefit–cost findings are broadly consistent with the limited estimates available in the international literature.

Findings against Expenditure Review Principles

Appropriateness of the programme

The programme should be deemed appropriate if:

- there is a market failure
- the additional R&D that the programme induces (assuming it does so) generates spillovers.

Limited available evidence in the literature suggests that R&D is likely to lead to spillovers. Given this, the programme is appropriate.

However, there are likely to be other government policies that also generate spillovers and therefore may be more appropriate than the R&D TI.

Effectiveness of the programme

The effectiveness of the programme is determined by the extent to which the programme successfully induces additional R&D, compared to the extent that tax revenue is forgone. Based on the survey results, and supported by the literature, the additionality of the programme is estimated to be in the range of 0.3 to 1.5. The assumed central estimate is 0.5 for large firms and 1 for SMEs, with an overall weighted average rate of 0.8.

Under this assumption, the programme is deemed to be effective in inducing additional R&D in the economy, but may not be effective in generating public benefits greater than the tax forgone.

Efficiency of the programme

There are two ways to consider the efficiency of the R&D TI programme, depending on the baseline to which it is compared.

An assessment of the efficiency of the programme compared to a situation in which nothing is done would consider both the direct private benefits to R&D TI recipient firms and the benefits to the wider Australian economy. This would be compared to the total cost of the programme, including the forgone tax revenue, deadweight loss of taxation, administration costs and compliance burden.

Alternatively, the efficiency of the programme can be compared against a scenario in which the funds used under the programme are used in other ways. Usually, there are other ways to achieve the same policy outcome. Alternative uses of the funds (such as tax cuts) would result in a greater benefit to the Australian economy.

As indicated in the benefit–cost results presented in this report, the programme is likely to be efficient in covering its costs (generating a benefit–cost ratio of at least 1:1). However, it is less likely, but not impossible, that the programme will generate higher returns (that is, a higher ratio) than other alternative uses of the same funds.

Integration

The department, and AusIndustry in particular, works closely with the ATO to administer the R&D TI programme. Each agency has clear roles and responsibilities, but they also work together effectively, particularly on compliance under the programme.

Despite this, there is incomplete information sharing between the department and the ATO. The department does not have access to all relevant data held by the ATO that would help in understanding and evaluating the use of the programme.

Performance assessment

AusIndustry maintains internal performance monitoring systems and conducts customer surveys to track its success in programme delivery. It also has in place procedures for ongoing improvements in programme administration.

This review is the first comprehensive evaluation of the R&D TI programme from a public policy perspective. Investments in improved outcome monitoring and data collection are essential in future programme evaluations. Even with improved data, however, there will be ongoing challenges in definitively assessing the efficiency and effectiveness of the programme.

Strategic policy alignment

The R&D TI aligns with other government strategies, in particular the Industry Innovation and Competitiveness Agenda and the Boosting the Commercial Returns from Research strategy.

Theory and analysis suggest that the R&D TI leads to spillover benefits that take the form of productivity improvements.

Recommendations

Based on the results of the research conducted for this review, we have made recommendations on possible improvements to the programme.

Lowering compliance costs

Any actions to lower compliance costs (provided there are no implications for the integrity of the programme) will result in an improvement of the programme.

While it is difficult to provide a benchmark, compliance costs for the programme are in relatively high proportion to the potential benefits of the programme. Lowering compliance costs has the potential to increase net benefits from the scheme.

One method for reducing the compliance cost for firms would be to continue to improve the accessibility and nature of guidance material about the programme while increasing the ease of interacting with the programme regulators.

One strategy in this area is to continue to use modern web-based methods to convey information to participants, particularly information about the specific definitions relating to eligible R&D expenditure. Web-based products already in the market, while not directly suitable for use by AusIndustry, indicate the possibilities for effective and contextual information dissemination.

Another proposal to reduce compliance costs that arose from stakeholder consultations is to allow for the registration of a single project extending over multiple years in a single application process. This would avoid duplication of effort across more than one year.

Increasing additionality

Because additionality is a central driver of the benefits of the programme, efforts to increase it would be worthwhile. Our analysis concludes that a 0.1 increase in the

average additionality rate could yield benefits of between \$77 million and \$566 million per year.

As noted, however, the additionality rate for an individual firm is determined by a range of factors outside the control of the programme. Therefore, efforts could be focused on increasing the average rate under the programme through modifying the composition of firms in the programme.

Average additionality could be maximised by increasing the proportion of participants with high individual firm additionality. We therefore recommend that the programme maintain its relative focus on small firms (which empirically have higher additionality rates).

Further, there is some suggestive, but far from definitive, evidence that changing the timing of registration relative to the conduct of the R&D may lead to higher additionality. In particular, requiring registration before or during an R&D project (rather than after it has taken place) seems to have led to higher additionality in some international examples.

Enhancing the information base

As noted throughout this review, there are significant difficulties in measuring additionality and spillovers arising from the R&D TI. This means that a sound quantitative estimate of the overall benefits of the scheme to the economy (or an estimate of the value that taxpayers receive for their expenditure) will always be subject to considerable uncertainty.

While the nature of these factors means that they are likely to remain uncertain to some extent, improvements can be made to the information base held by the government to allow for a better understanding of the impacts of the programme.

We note that the programme does not currently contain systematic measures to allow for ongoing economic evaluation. While it will not deliver benefits immediately, the steady building up of an evaluation information base is likely to help in delivering value for money to the taxpayer.

This will be particularly useful for future evaluations of the programme, and for monitoring change in the programme over time.

Key recommendations in this area include:

- 1 *Undertake wider and more systematic analysis of information contained in tax returns, which for this review was not possible.* Tax information is of course sensitive and is quite correctly held securely and in confidence by the relevant authorities. However, given the potential benefits in understanding the impacts of the programme, we consider it worthwhile to systematically explore ways of appropriately using this information.
- 2 *Work with the Australian Bureau of Statistics to enhance the current business R&D survey.* The existing ABS survey is not directly suitable for evaluation purposes but it could become so with the addition of evaluation-type questions. Our experience with

conducting a special-purpose survey suggests that these surveys will become more difficult in the future (particularly in achieving a high response rate). Working with the ABS will both reduce the burden on firms and increase the likelihood of an adequate level of response.

- 3 *Include broader evaluation questions as part of the registration process.* There is clearly a trade-off here with the need to minimise compliance costs, but it is worth exploring the possibility of incorporating evaluation questions into the registration database.
- 4 *Consider the possibility of controlled experiments,* as recommended by Thompson and Skali (2016), to improve knowledge of the responsiveness of firms to incentives to increase R&D. Appropriately constructed controlled experiments have the potential to reveal new information not currently available to policymakers about the effectiveness and optimal settings of R&D policy, including the R&D Tax Incentive.

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Acronyms and abbreviations

ABS	Australian Bureau of Statistics
ATO	Australian Taxation Office
BAU	business as usual
BCR	benefit–cost ratio
CGE	computable general equilibrium
CI	confidence interval
CRC	cooperative research centre
GDP	gross domestic product
IICA	Industry Innovation and Competitiveness Agenda
IP	intellectual property
NISA	National Innovation and Science Agenda
NPV	net present value
OECD	Organisation for Economic Co-operation and Development
PC	Productivity Commission
R&D	research and development
R&D TI	R&D Tax Incentive
RDEX	R&D expenditure
RSP	Research Service Provider
SBIR	Small Business Innovation Research Program (US)
SME	small to medium enterprise
SR&ED	Federal Tax Credit for Scientific Research and Experimental Development programme (Canada)
TIAC	Tax Incentive Advisory Committee
WBSO	Wet Bevordering Speur-en Ontwikkelingswerk (Netherlands)

A Review Terms of Reference and Expenditure Review Principles

Review Terms of Reference

The Terms of Reference were developed to review the R&D TI programme against the Expenditure Review Principles used by the Department of Finance as well as the requirements of the Tax White Paper.

1. Need

- a) How is the R&D Tax Incentive programme, its policy rationale (including addressing market failures) and objectives, contributing to meeting the Government's broader economic objectives as articulated in the Industry Innovation and Competitiveness Agenda?
- b) Is the R&D Tax Incentive the right vehicle to drive business innovation?

2. Design and Theory

- a) To what extent does the design and features of the R&D Tax Incentive, including changes introduced through recently passed legislation, appropriately address the policy objectives of the programme?
- b) How does the R&D Tax Incentive programme compare with international practice?
- c) Does the R&D Tax Incentive have a role to play in facilitating greater researcher-industry collaboration?

3. Process and Implementation

- a) Since its introduction, has the R&D Tax Incentive programme been effectively implemented and administered?
- b) Is the R&D Tax Incentive programme well understood by stakeholders and easy to access?

4. Outcomes and Impacts

- a) To what extent does the evidence indicate that the R&D Tax Incentive is meeting its policy objectives, including encouraging additionality, as well as enabling the improved realisation of returns and improved decision making by firms, and identify areas for further improvement?

- b) How does the R&D Tax Incentive contribute to Australia's international competitiveness, at both the firm level and for the innovation system as a whole, and can it be improved upon?
- c) How can the impacts of the R&D Tax Incentive programme best be evaluated in the future?

5. Cost and Efficiency

- a) Can the cost of the R&D Tax Incentive programme be better understood and estimated?
- b) In light of the Government's Deregulation Agenda, how could the R&D Tax Incentive programme be made more efficient and less burdensome on participants?

Expenditure Review Principles

The Department of Finance's Expenditure Review Principles require evaluations to consider a programme's appropriateness, effectiveness, efficiency, integration, performance assessment, and strategic policy alignment.

1) Appropriateness

- Activity is directed to areas where there is a role for government to fill a gap left by the market:
 - social inclusion—government activity should address social inequity by redistributing resources in ways that improve opportunity and support for individuals, families and communities, allowing them to participate in the economy and society consistent with the Government's social inclusion agenda; or
 - market failure—government activity should address market failures by improving social and economic welfare through improved resource allocation, where the benefits of government intervention outweigh its cost (including in the provision of public goods, for example, in environmental sustainability, national security and defence); and
 - Activity is undertaken by the most appropriate level of Australian government—whether expenditure is better undertaken by the Government or a lower level of government.

2) Effectiveness

- Activities to have clear and consistent objectives and be effective in achieving their objectives and represent value for money for the expenditure of taxpayer funds; and
- Activity involving tax expenditures or financial instruments (for example, guarantees, loans or investments) to demonstrate why an outlay programme is likely to be less effective in achieving the activity's objective(s).

3) Efficiency

- Government programs to be administered and delivered in the most efficient way achievable, taking into account both short and long term economic and fiscal consequences;
- Activity targeting market failure in one market to not unnecessarily reduce economic efficiency in other markets; and
- Consideration to be given as to whether part or all of the cost of a Government activity should be recouped directly from the beneficiaries of that activity.

4) Integration

- Government agencies to be able to work together effectively to consistently deliver the Government's policy objectives within clearly defined lines of responsibility.

5) Performance assessment

- Government activity to be subject to robust performance assessment and measurement.

6) Strategic Policy Alignment

- Proposals to address whether the activity is consistent with the Government's strategic long term policy priorities, in particular to areas that help sustain economic growth through improved productivity and participation.

B Cross-country comparison of incentive schemes for R&D

The tables in this appendix outline the high-level details of incentive schemes for R&D in different countries.

Table B.1 Cross-country support schemes for R&D activity

Economy	Corporate tax rate	Turnover	Refundable credit	Credit	Enhanced deduction from taxable income	Patent box	Direct grants	Comments/other measures
–	Per cent	Million LCU ^a	Per cent of eligible R&D expenditure	–	Per cent of R&D expenditure that is tax deductible	–	Per cent of project cost	–
Australia	30	< 20	45	–	–	–	–	R&D expenditure must be eligible, and is not deductible
	30	>20	–	40	–	–	–	Credit rate falls to 30% for R&D expenditure > \$100m
Austria	25	All	10	–	–	–	–	Subcontracted R&D expenditure limited to €1m
Belgium (asset measures)	33.99	All	See comment	–	14.5 (per cent of R&D assets—once-off deduction); or 121.5 (per cent of depreciation assoc. with R&D assets)	–	–	Taxpayers can choose between deductions Excess deductions carried forward indefinitely; become a refundable credit after 5 years Accelerated depreciation (3 years)
Belgium (other)	33.99	All	–	–	80% of patent income	–	80 (paid by regional governments)	Other measures: 80% withholding exemption on wages on qualifying researchers (who have at least masters degrees); some conditions/exemptions Some innovation premiums (eliminate tax and social security withholding requirements)
Canada (federal)	11–31	Small ^b	35	–	–	–	–	Credit rate for small bus is 35% for R&D expenditure up to \$3 million and 15% for expenditure over \$3 million
	11–31	Large	–	15	–	–	–	Credits on expenditure over \$3 million (which are calc. with 15% rate) are only 40% refundable.

Economy	Corporate tax rate	Turnover	Refundable credit	Credit	Enhanced deduction from taxable income	Patent box	Direct grants	Comments/other measures
–	Per cent	Million LCU ^a	Per cent of eligible R&D expenditure		Per cent of R&D expenditure that is tax deductible	–	Per cent of project cost	–
								Credits on capital expenses are only 40% refundable
Canada (provincial)	11–31	All	4.5–37.5	–	–	–	–	Rate and whether credit is refundable or partially-refundable depend on jurisdiction
Canada (specific)	11–31	All	–	Range	–	–	–	Special tax credits for IT, media, video games, film and industries that develop new technology for climate change, clean air, water and soil quality
France	34.43	All	–	30 → 5	R&D expenses are deductible	15	Available	Credit is 30% of first €100m of R&D expenditure, 5% thereafter; credit is carried forward for 3 years; Accelerated depreciation of assets used in R&D Innovation credit for SMEs (sales < €50m): 20% of qualifying, downstream expenses (e.g. prototypes, pilots, etc.)
Germany	30 (average) ^c	All	–	–	–	–	50	Per project grants, usually for collaborative projects Average size of grants is 50% of eligible project costs (higher rates available for SMEs) Selection criteria for grants include: levels of innovation, technical risk and economic risk Eligibility is not limited to particular industries, though financial services are usually excluded R&D loans also available

Economy	Corporate tax rate	Turnover	Refundable credit	Credit	Enhanced deduction from taxable income	Patent box	Direct grants	Comments/other measures
–	Per cent	Million LCU ^a	Per cent of eligible R&D expenditure		Per cent of R&D expenditure that is tax deductible	–	Per cent of project cost	–
Ireland	12.5	All	–	25	R&D expenses are deductible	–	Available	25% credit applies to all R&D expenditure below first €300k For expenditure above €300k, only expenditure in excess of 2003 level is subject to credit If company did not exist in 2003, all expenditure can be subject to credit
Israel	25	All	–	–	–	–	20 (for investment in man. facilities in 'priority area A' 50 (up to 60 in priority area A)—for approved R&D expenditure, which must be repaid if project is successful	Goal: encourage R&D that generates exports Chief scientist approves companies (based on technological skill, plan to implement in Israel and high innovation standard) Companies that are generally eligible are: pharmaceuticals, software & hardware and energy & utilities If approved, company tax rate is 6% (companies in 'priority area A') or 12% (other)
	25	>20 000	–	–	–	–	–	Tax rate for large companies is 5% (priority area A) or 8% (other)
Italy	27.5 ^d	<500	–	50	20 (for R&D intensive start-ups), up to €1.8m, until 2016 Wages for R&D employees are deductible	–	FIRST Fund grants for projects managed by Ministry of University and research	Credit is on incremental, eligible R&D expenses, up to a max. of €2.5m Further 35% tax credit hiring researchers

Economy	Corporate tax rate	Turnover	Refundable credit	Credit	Enhanced deduction from taxable income	Patent box	Direct grants	Comments/other measures
–	Per cent	Million LCU ^a	Per cent of eligible R&D expenditure		Per cent of R&D expenditure that is tax deductible	–	Per cent of project cost	–
							Regional cash grants available R&D intensive entities	
Japan	36 ^e	<¥100 capital	–	12	–	–	–	Credit is limited to 20% of nat. corp. tax liability
Japan	36 ^e	>¥100 capital	–	8–10	–	–	–	Additional credits on incremental R&D also available Additional credit system for companies conducting R&D with R&D institutions
Netherlands	20–25	All	–	See note (WBSO)	160 (per cent of non-wage R&D expenses)	5 (per cent of income earned on inventions put into 'box', net of development costs)	–	Companies must qualify for WBSO benefits. WBSO: wage tax and social sec. contributions are reduced by 35% (50% for start-ups) on the first €250k of R&D wages, and by 14% on remaining costs (max reduction is €14m). For invention to go in innovation box, lead-up R&D efforts must qualify for WBSO benefits
	20–25	SMEs	–	–	–	5	–	5% tax rate on 25% of income from innovation box, before development costs are netted out; capped at €25k annually Designed for SMEs with low income from innovation box. Benefit can be for 1,2 or 3 years.
Singapore (base deduction)	17	All	–	–	100	–	–	Wages, materials, utilities and payments to R&D organisations incurred are deductible. Deductions may be carried forward indefinitely Capital expenses (e.g. buildings) and acquisition

Economy	Corporate tax rate	Turnover	Refundable credit	Credit	Enhanced deduction from taxable income	Patent box	Direct grants	Comments/other measures
–	Per cent	Million LCU ^a	Per cent of eligible R&D expenditure		Per cent of R&D expenditure that is tax deductible	–	Per cent of project cost	–
								of rights are not deductible
Singapore (additional deduction)	17	All	–	–	200	–	–	Deduction rate applies to certain R&D expenditures approved by government All claimed R&D deductions are capped at 200% of actual expenditure Additional deductions close in 2015
South Korea	11–24.2	SME	–	Variable	–	–	–	Credit is larger of 50% of current R&D less average of 3 prior years or 25% of current R&D Credit of 30% of R&D if R&D is part of 'new growth engine industry' or 'original source tech. programs' Extra tax credit, equal to 7% of purchase price for certain IP purchased from third party Korean resident
South Korea	11–24.2	Large	–	Variable	–	–	–	Credit is larger of 40% of current R&D less average of 3 prior years or 8% of current R&D Credit is 20% of R&D if R&D is part of 'new growth engine industry' or 'original source tech. programs' Credits can be carried forward 5 years (no refund)
	11–24.2	All	–	See note	100	–	–	Credit of 10% of cost of certain R&D equipment (e.g. machinery) if used to conduct R&D activities. Unused credits may be carried forward 5 years (no refund)

Economy	Corporate tax rate	Turnover	Refundable credit	Credit	Enhanced deduction from taxable income	Patent box	Direct grants	Comments/other measures
–	Per cent	Million LCU ^a	Per cent of eligible R&D expenditure	–	Per cent of R&D expenditure that is tax deductible	–	Per cent of project cost	–
								R&D expenses are fully deductible. Further, 3% of revenue can be claimed as a 'R&D reserve deduction'; but eventually re-added to revenue.
UK	20	< 100	See note	–	225	–	–	Total SME benefit is €7.5m per project; no minimum spend (min. removed 2012) If company is making a loss, it can carry forward amount equivalent to loss plus enhanced allowance, or it can receive a refundable (cash) credit of 14.75% of R&D expenditure
	20	>100	–	10	130	–	–	No minimum (min. removed 2012) From 2016, enhanced deduction will be replaced with 10% taxable credit
	20	All	–	–	–	10	–	Innovation box contains patented inventions and certain other innovations R&D capital costs are excluded from special R&D deduction; 100% of these expenses are deductible
US	15–35	All	–	Variable	100; but deduction reduces by amount of tax credit	–	–	'Traditional' credit of 20% of R&D expenditure less base amount ^f ; or 'Alternative' credit of 14% of R&D expenditure less 50% of average of 3 prior years; if there is no R&D in any one of 3 prior years, credit reduces to 6% of R&D expenditure Special credits for basic research, payments to energy research consortia,

Economy	Corporate tax rate	Turnover	Refundable credit	Credit	Enhanced deduction from taxable income	Patent box	Direct grants	Comments/other measures
–	Per cent	Million LCU ^a	Per cent of eligible R&D expenditure		Per cent of R&D expenditure that is tax deductible	–	Per cent of project cost	–
								Computation adjustments reduce the value of tax credits ^g Unused credits can be carried forward 20 years Credits are not subject to a cap Generally credits are not refundable ^d

^a Local currency unit (e.g. 20 million LCU in Australia is A\$20 million)

^b 35% tax credit is for small, Canadian controlled, private corporations. The corporate group must have had a taxable income in the previous year of less than the 'qualifying income limit', which is determined in calculation

^c According to Deloitte (2014) the effective, combined income rate (corporate income tax, trade tax and solidarity surcharge) is 30%

^d Extra tax of rate 3.9% may apply, depending on region and industries

^e Approximate rate. Includes general, national tax rate (28%) plus other, local, corporate tax rates.

^f Base amount is determined by calculation

^g Adjustments include: (1) Deduction of eligible R&D expenses must be reduced by size of tax credit. Alternatively, R&D tax credit rates are reduced to 13% and 9.1%; (2) minimum base amount for traditional credit is 50% of R&D expenditure; (3) max effective rate for traditional credit is 6.5%; max effective rate for alternative credit is 9.1%

Note: Singapore allowed a number of additional deductions that expire in the 2015 tax year. These are not included in this table.

Note: The purpose of Table B.1 is to provide an accessible, high level comparison of incentives for R&D activity across comparable countries. By necessity, some details of different incentives are missing.

Source: Deloitte 2014; PWC website (accessed September-December 2015); AusIndustry; <http://www.cra-arc.gc.ca/txcrdt/sred-rsde/clmng/clmngsrd-eng.html#N101C2> (accessed December 2015); <https://www.gov.uk> (accessed December 2015)

C Relevant responses to the Australian Government's tax discussion paper, Re:think

Re:think, the Government's initial discussion paper for the Tax White Paper process had a specific question about the R&D Tax Incentive. The responses to this question (44 in number) have been reviewed and are summarised here.

Terms of Reference 1: need for R&D TI

Need for government support

- 42 submissions explicitly argued or implicitly acknowledged the government should support R&D.
- 1 did not argue for or against government support for R&D.
- 1 explicitly argued the government should not support R&D (by arguing the R&D TI should be scrapped and not proposing an alternative).

Size of government support

- 11 submissions explicitly argued the size of government support for R&D should be expanded. There was a broad range of views on this, including expanding the scope of R&D activities, removing thresholds in the current system and simply making the system more generous.
- 1 explicitly argued the level of support is appropriate
- 2 explicitly argued the size of the government support for R&D should be reduced
- 30 did not explicitly comment on the size of government support.

Terms of Reference 2: design and theory

- 3 argued the R&D TI should be replaced with another scheme that supports R&D. Arguments included that the government should support R&D with grants, or by taking equity stakes in projects.
- 3 acknowledge/argue the current incentive design should be retained, but other measures should be added. Arguments included 'angel investors' should be given income tax incentives, 'patent box' measures should be introduced in Australia and that the R&D TI should sit alongside business incentives to support CSIRO.
- 12 argued that the R&D TI should be redesigned in such a way that would change its nature. Arguments here fell into two categories, as follows.

- Submissions called for more incentives for ‘collaborative’ research, including higher incentives for companies that undertake research by collaborating with universities.
- Submissions called for a more targeted and/or nuanced system, including more support for ‘strategic’ R&D and/or a suite of incentives that change as the nature of the technology changes (for example, more support for R&D in high technology). One submission specifically suggested making R&D in agriculture industry more attractive.
- 5 submissions argued the R&D TI should be retained, but with adjustments that do not alter its nature.
 - Submissions called for changes in incentive rates. One called for a review to determine affordable incentive rates. In contrast, another submission called for 100% incentive rates.
 - Some submissions suggested more support for SMEs. Other submissions called for more support for larger companies, including lifting the threshold for the refundable component.
- 14 submissions argued the R&D TI should be retained, in essentially its current design. 7 submissions explicitly argued that stability in this policy area is important. Other submissions argued the R&D TI is good and/or effective system, and should be retained.
- 1 submissions argued the R&D TI should be scrapped.
- 6 submissions made no comment on the design of the system

Terms of Reference 3: process and implementation

- 2 submissions argue the current system does not create unnecessary administrative burden, or that it works well
- 3 submissions argue the current system creates an unnecessary administrative burden, or works poorly. Submissions argued for more education (including to reduce waste), online tools, subsidised accounting services and simply that the current scheme is too complex. One submission called for a streamlined application process.
- 8 submissions argued the mechanics of the system should be adjusted. 5 submissions argued that quarterly payments should be introduced (one argued against this). 4 submissions commented on how the R&D TI system interacts with franking credits.
- 31 submissions do not comment specifically on the administrative burden, or mechanics of system

Terms of Reference 4: outcomes and impacts

- 8 submissions argue that’s the R&D TI has additionality, but do not provide supporting data. 2 submissions argued that that the R&D TI causes R&D to be located in Australia (that would be located elsewhere if not for the system), while 2 argued the scheme has additionality for R&D at SMEs

- 1 submission argues the R&D has spillovers, but does not provide supporting data
- 2 submissions argue the R&D TI has additionality and spillovers, but do not provide supporting data
- 2 submissions argue additionality and/or spillovers, and provide supporting data
- 31 submissions do not provide a sophisticated argument or data that demonstrates the outcomes of the programme

Terms of Reference 5: efficiency

- 1 submission expects that the benefits to the economy of the R&D TI outweigh the costs to the economy.
- 43 do not consider or make a judgement on the economy wide costs and benefits of the R&D TI.

D Consultation summary

This appendix summarises the views and opinions that were garnered through the consultation process. These comments do not reflect a view of whether or not the comments were valid, convincing or widely held.

Overall impressions

Overall, stakeholders were pleased with the programme and were clearly in favour of continuing and improving it. One stakeholder said ‘the R&D Tax Incentive is the jewel in the crown of innovation policy, we need to protect it’. The R&D Tax Incentive is seen as a **fundamental part of Australia’s R&D policy**.

The R&D Tax Incentives has been **more successful than expected** (in transition from the concession), particularly for small businesses and those in loss. Noted strengths of the programme include:

- The self-assessment process is quick and has low administrative costs
- The improvements to treatment of foreign owned companies and overseas findings are welcome. The overseas findings helps medium companies stay in Australia.
- It provides certainty and predictability in how much and when money will be received
- Firms have to commit to spending in advance which ensures a degree of personal investment and commitment to the projects.
- The current programme is creating a pro-R&D environment, with R&D happening in Australia people are more likely to study in STEM areas.
- Every start-up (known to a participant) has at some point relied on the R&D TI—it increases the chance of survival for firms.
- The programme’s requirement to keep records is forcing (some?) SMEs, particularly start-ups, to adopt a more professional approach towards general business administration and leading to better-informed decision-making.

One firm gave this feedback on the programme:

‘Overall we believe that the program is effective and pragmatic. We see different approaches in different countries and often the programs directly or indirectly motivate companies to digress from their own project. Or they spend more time on submitting proposals for calls and grants than keeping up the momentum on the development that is on the critical path. The R&D Tax incentive supports what the company is set up for and helps bear the cost of that.’

A clear trend in the consultation process was the **need for certainty**.

- Certainty has two dimensions—certainty that a business/activity is eligible for the Incentive and certainty in the amount of the benefit they would receive.
- Constant changes (or the prospect of changes) causes instability, which actually causes harm to the innovation system.
 - Continuity and confidence are critical in our innovation policy settings
- Investment decisions in some cases have time horizons of up to 15–20 years and certainty is required for the Tax Incentive to be considered in the decision making process.
- The retrospective nature of the proposed rate reduction measure (to previous financial year) is a concern.
- Changing programme settings with each change of government, and even each change of leader, prevented the programme from being used as intended and was setting it up to not deliver as expected/on its potential.
- Where there is uncertainty about the programme, firms do not incorporate the incentive into their decision making process and therefore the programme will clearly not meet additionality requirements, rather it is collected as an after-the-fact bonus.
- Constantly changing the policy sends the wrong signals to investors (i.e. lack of certainty and even sovereign risk associated with decisions already made) and can actively send potential investors away.

Many stakeholders, however, expressed **concern around the review process**.

- There was a consistent comment of review and submission fatigue, to the point where some stakeholders declined to participate in the process because they feel it is pointless.
- A related concern was that all the various reviews and policy activities in the space were not being coordinated.
- Some stakeholders felt the programme had not been running long enough for a review to be worthwhile.
- Reviewing the programme instils further uncertainty in the business community and gives a feeling that the programme is under constant threat of being revoked.

In conducting the review of R&D policy, the objectives and budget envelope should be clearly specified so that the optimal policy approach can be determined.

The R&D Tax Incentive is just one piece in the bigger R&D system. Other parts of the system include education, collaboration, corporate tax rates and the legal (IP) environment. Currently Australia is lacking a national plan and research priorities.

Additionality

Investment decision

Firms make decisions about investment in R&D based on a number of considerations, and these considerations differ from industry to industry, and according to the circumstance of the firm. The R&D TI is a consideration, but the importance each firm places upon it differs from firm to firm.

- Location of R&D is often considered mobile by firms (IT firms, clinical trials and other multinationals). For some incentives/taxation may be the primary consideration.
- Co-location of facilities (for example with manufacturing facilities) is often a consideration. This may also flow the other way, with manufacturing being established where R&D is being conducted. This may mean that the R&D TI leads to manufacturing investment too.
- In the medical space—firms coming because clinical trials can be done faster here
- Availability of technology
- Supply of skilled labour
- Access to key clients/markets
- Corporate strategies
- World class researchers
- Quality of institutions and collaborators
- Clustering. Need a critical mass to create an ecosystem like Silicon Valley—network effects

Constraints on investment in R&D include:

- Funding
 - There is a lack of venture capital in Australia because after the .com boom and the GFC superfunds stopped funding VC
- High cost of labour (for some skill sets, for other—such as software engineers—Australia is relatively low cost for the quality)
- Availability of labour (e.g. competing for good software engineers with investment banks who pay well)

Drivers of R&D investment:

- Firms need to be constantly improving to be the best (or second best) in order to survive.
 - This is used as an argument against the R&D TI because R&D would have been done anyway
 - And as an argument for, because without the R&D (supported by the R&D TI) then Australian firms would fail.

- The more start-ups that stay in Australia and attempt to grow, the more critical mass we build up which is capable of supporting more activity. A start-up ecosystem has a powerful network effect.

International competitiveness in R&D environments were consistently raised in support of maintaining or increasing the R&D TI.

- UK, Ireland, Singapore, South Korea and Switzerland are key competitors.
- With increasing popularity and visibility of tax incentives, firms are constantly undertaking international comparisons to decide where to invest
- Australian branch offices are often competing for R&D spend within global companies

Automotive firms are closing production facilities but maintaining R&D (after 2017 there may be further consideration of this, they are internationally mobile) – because:

- Strong links with universities
- Part of 24hr global operations
- Labour force quality (with university education and real world experience)
- Climate variety is suited for testing of cars

In extractive industries, R&D decision making (with CSIRO) is removed from tax affairs

For medical firms (clinical trials), investment considerations include the patient pool, regulatory environment, cost efficiency (including incentives), access to relevant expertise, infrastructure and environment. Clinical trials may need to be conducted in overseas markets to meet the regulatory requirements of target market overseas.

R&D in mining is both location specific and non-location specific (e.g. collaboration with unis and CSIRO).

Impact of R&D Tax Incentive

Generally, stakeholders stated that the R&D TI is leading to projects being undertaken that would not have otherwise, bringing forward investment, completing a project faster, investing for a longer period of time (and thereby increasing the chance of success), expanding the scope of a research project or taking up risky projects. Further details depended on the participant/industry:

- R&D TI generates additional R&D in small companies
- R&D TI delays small firms from moving overseas (this is often encouraged by foreign Venture Capital funds)
- Australian start-ups are often forced to list on a stock exchange ‘too early’ for the primary reason of raising capital and at a price disadvantage as they have yet to prove the value of their business—R&D TI enables them to delay this option thereby improving their value proposition
- In agriculture R&D would not be undertaken without the R&D TI
 - One group claimed agricultural R&D levies were preventing the growth of home grown private sector research firms (e.g. an Australian Bayer or Monsanto)

- Start-up medical firms would not survive without the R&D TI because of a lack of VC
- R&D TI has the greatest impact on new projects and start-ups, less on improving processes because the improvements are needed to survive and compete
- R&D TI is particularly relevant for firms under \$20m turnover
- R&D TI supports R&D in large firms and multinationals—large firms ‘need’ R&D too

It was estimated that around 4000 firms (of the 13000 in the programme) were less than 4 years old and another 4000 were between 4 and 8 years old (AusIndustry can provide these figures).

Despite many participants making positive statements regarding the additionality of the programme, many were also opposed to the concept of measuring additionality.

- Seen as a distraction and an unachievable task as it is all but impossible to definitively prove given the vagaries of cause and effect and the lack of robust data
 - It’s a change agent—it changes the thinking of investment decisions
- The volume based nature of the programme (rather than incremental) nullifies the additionality question
- Not possible to show/prove additionality so should not be considered in the review

While in many cases, R&D is needed to do BAU, the R&D TI influences this too yet the extent of this influence can’t be measured. If the incentive were removed, routine innovation/research will be less likely to occur.

R&D TI encourages R&D in different ways

- R&D TI is often used to fund recruitment (indicator of financial constraints)
- R&D TI helps manage risk by increasing the rate of return
- Establishing one project, through the R&D TI, can lead to more projects
- R&D TI drove companies to consider Australia, once here they found the researchers to be very good
- R&D TI brings R&D to Australia, facilitates market activity
- For an R&D start-up—more money means more R&D

Many specific examples of additional R&D focused on the location of the R&D:

- Such as with these start-ups:
 - Canva would have moved to the US without R&D TI and Commercialisation Australia Grants—have 40 software engineers
 - Autopilot—moved to the US but now starting to establish a team in Australia to take advantage of the R&D TI
 - Atlassian—sales and marketing moved to the US to be closer to the market, but the engineering team stayed in Australia
 - Elastagen—R&D TI kept the team here despite $\frac{3}{4}$ of funding coming from overseas (which was a strong pull). Manufacturing and other activities overseas, development in Australia.
 - ... Life science companies are pre-revenue for long periods of time, so places with better tax structures (such as Ireland) are not attractive yet. Later in

their lifecycle they may be drawn to better corporate tax rates, but the deeper the roots here the more likely they will stay. This will build a more mature industry here.

- And these other firms:
 - Agilent technology—spectroscopy—manufacturing moved overseas but they increased the number of skilled workers doing R&D in Australia
 - Hewlett-Packard—being pushed to move international
 - CSL—next big R&D project will take them over the threshold and they are now looking at where to invest

Firms not in the programme

The stakeholders were able to give some insights into the types of firms that are not registered under the programme.

- The ownership structure is excluded from the programme, e.g. trusts, partnerships, not-for-profits
- Firms had been in the programme but dropped out because of compliance costs and/or a bad experience with the programme (experience could be with AusIndustry, ATO or an agent)
- Firms choose not to join because of other tax reasons—effects on share prices and franking credits
- Some firms aren't aware of the entitlement
- The cost of compliance is greater than expected benefits
- For a big firm in loss there is no direct benefit, costs of participating not worth it

Other firms may not be claiming as much as they could:

- Companies may exclude major projects because they think it is outside the definition and not prepared to take the risk of a negative finding. They have conflicting advice from consultants—ambiguity of what is in and out driving confusion

The number of firms using the programme could be increased:

- Estimated that there are 25,000 firms doing R&D and if they knew about the scheme they would do more R&D
- More firms would use the programme if the \$20 million turnover cap on the 45% refund was relaxed
- Some foreign investors are coming (particularly in life sciences) that will increase the number of firms in the programme

However, some firms are in the programme but shouldn't be. They are re-badging expenditure as R&D, taking advantage of the self-assessment nature of the programme and risking audits.

One example of difficulty in participating:

- Firms contributing to CRCs can claim the R&D TI, however, where a peak body contributes to a CRC on their behalf the members of the peak body cannot claim the

R&D TI because the peak body is a tax paying not-for-profit. This is mostly a problem for small firms and sole traders. It is useful to have industry associations contribute to CRCs because having multiple small firms contributing is an administrative difficulty.

Spillovers

There was limited input on the existence and nature of spillovers from additional R&D. The pathways mentioned included:

- Knowledge spillovers:
 - Firms maintain competitiveness through incremental R&D, which builds IP and capability
 - New knowledge spurs more knowledge and collaboration –increasing returns to knowledge
 - Knowledge can be spread through publications
 - Firms conduct incremental research, building on work by other companies
- Economic activity/interactions:
 - Once a firm is established in Australia (because of the R&D TI) then they are more likely to stay in Australia as they move into commercialisation stages and manufacturing
 - Spillovers occur from large firms to small, for example, small firms fitting into supply chains, larger firms push R&D down the supply
 - In agriculture sharing of R&D is pretty strong, including extension work by state governments
 - The automobile sector was the largest manufacturing pipeline of technology transfer—creating spillovers to other advanced manufacturing
- People
 - Employees develop skills in large firms then spinoff as start-ups
 - Medical technology firms get benefits from expertise in other industries (food, mining, manufacturing), transfer of workers from manufacturing (MTAA)
 - Churn in the job market is a mechanism for spillovers, it moves knowledge and 'knowledge of doing R&D'. This churn is measurable
 - People moving in an area, collaborate, cluster (e.g. Ballarat)
 - Research can save lives (e.g. mine safety)

In some instances (e.g. mining), Australian R&D is being exported. The R&D is conducted in Australia due to clustering, movement of people, discussions within industry and collaboration with researchers. The universities are able to build on the collaborative research and sell further R&D overseas.

A clear area of significant spillovers is in the medical research (clinical trials) area:

- Australian patients get early access to new products and treatments (and continued access after the trial period)
- faster regulatory approval

- Treatments are fully funded by the researching firm (with no cost to the public health system)

Some feedback is that incremental improvements in large firms through R&D have few spillovers.

Where the R&D is conducted overseas, there is no interaction with Australian researchers, and so spillovers from overseas R&D may be less than domestic R&D.

Many stakeholders stated increased economic activity, jobs and exports as spillovers, this was extended to increased salaries paid and increased income tax revenue. These are not genuine spillovers.

Administration of the programme

Compliance costs

Most stakeholders noted that the compliance costs were not excessive (except in some audit/review cases). It was estimated that the cost of compliance was probably less than 20%, in the order of **10–15% of the benefit** received.

- Compliance is not much more than doing tax—1 day of accountant's time. R&D plan is more onerous—2–3 days but this is reasonable given the benefit
- The biggest compliance cost is the initial set up and paperwork, the first registration was noted as being the most burdensome.
- Getting set up to capture the right data, especially for a new/small business, is a considerable cost
- Participants are still getting used to the new programme, as familiarity grows it is expected that the compliance burden will decline.
- However, the burden is added to by constantly changing policies requiring changes to record keeping systems/practices as well as effort in understanding the changes.
- Compliance costs also escalate quickly with activity reviews/audits.
- First letter RFI could cost \$10,000. RFI could range from receiving a letter saying 'has been reviewed and all okay' to a site visit, to major issues. Where there are major issues the cost out-weighs the benefits, this is the minority of cases
 - An example was cited of a \$1,400 benefit subjected to an RFI
- The feedstock accounting requirements are complex and onerous, particularly for small manufacturers. Many firms avoid the costs by not registering feedstock which may not be technically legal.
 - MJA created their own bespoke models/templates for feedstock provisions.
 - For some firms the compliance costs for feedstock are enough for them to not register for the programme.
 - Example of a <\$20m furniture manufacturer creating new stock. Requires different treatment for the same stock in different contexts, i.e.:
 - ... Tested to death

- ... In the back shed
- ... On the sales floor
- ... Sold to customers

The compliance costs could be reduced by:

- streamlining the application process to reduce administrative burden, and improving communication
- shifting away from annual registrations
 - It was noted that there are risks and benefits to annual and multi-year registration. Annual registration encourages better documentation and awareness, multi-year post-R&D registration may lead to ‘grave digging’—not an incentive
- improving consistency in reviews across state offices and individuals. An ATO style system of sharing cases or review outcomes publically would help, and
- allowing a 2-tier compliance process for large and small firms to reduce the burden on small firms. (Transfer Pricing Policy—burden is reduced for small firms)

Documentation processes were a focus of the burden:

- Documentation requirements for the R&D TI are likely to be different to BAU documents
- However, as mentioned in 1. Overall impressions, there are some wider benefits to keeping the documentation—improving R&D processes/outcomes and business outcomes due to better accountability, decision making processes

Audit process

Stakeholders (mostly taxation agents) had feedback on the current audit/review process. Of particular note was the number of comments about consistency in AusIndustry assessors.

- Time to complete reviews can be excessive—up to 2 years (although this was noted to be very rare)
- The whole review process is uncertain and lengthy when it happens
 - An example was provided of notice being given of a 2014 claim being identified for review recently, when the 2015 claim had already been lodged using the same logic.
 - Even advanced findings can drag on and take too long
- The questions asked are too generic
 - site visits are often better/more productive due to their immediacy in explaining/clarifying details for the assessor(s)
- A common response from assessors is ‘that’s just standard product development’
- Individual AusIndustry assessor can affect the outcome due to inconsistency between assessors and state offices. Not all assessors have relevant experience to assess registrations.

- AusIndustry approach the process with a negative tone, adversarial, which puts the whole process on the wrong track
- There appears to be a sectoral bias in the administration against mining
- AusIndustry starting to use requirements not found in the legislation—e.g. requirements for ‘valid hypothesis’
- The current approach (relying on definitions, lengthy processes) is not consistent with government’s aim of cutting red-tape.

Suggestions to improve the audit process:

- The timing of reviews is exacerbated by the delay in lodgement times. Could make registration period much shorter. This should be okay for firms as SMEs want refunds quickly so don’t need 10 months, and large firms have the capacity to lodge forms quickly.
- The RFI/audit process should be better aligned with the registration form to make things easier/faster
- Audits should be focused on: first time claimants, change of agents, poor quality advisors (i.e. not the big four accounting firms)
- Assessors should adopt a client-service approach consistent with the programme providing an incentive to behave in a particular way
- Improve the consistency in findings, sharing (de-identified) determinations would help
- Overseas findings are an onerous process, would be better if included in the normal process, shouldn’t need a full finding in a self-assessment programme
- Remove some of the uncertainty from the programme by limiting the time over which historical reviews can be conducted (currently no time-limit as reviews can go back to 1985—firms can be asked to repay which could lead to bankruptcy, especially when subsequent claims are based on previous ones)

Role of agents

Most participants recognised agents played an important role in the programme:

- Agents help firms get started and for a small company this is an efficient use of their limited resources.
- Agents provide certainty, interpret the rules, bolster claims, withstand the scrutiny, help with the grey areas in the programme—ultimately add value (agent comment)
- Agents help small firms/start-ups as they are good at fitting R&D into the definitions in the legislation
- Agents typically have a wide range of fee options (sliding scale, size of claim, fixed fee, retainer, success fee)

Some concerns were also raised:

- Fees can be up to 30% of a claim
- Taking a percentage of the size of a claim creates the wrong incentives

- PwC's online Nifty service has commoditised service provision for SMEs
- It can be too expensive for small firms to use the Big 4 consultants
- There are some agents providing poor advice (Big 4 comment)
- The quality of agents has declined as the programme has expanded with more generous terms (specifically the 45% rate and its refundable nature)
- Some agents actively recruit clients with questionable promises of generating returns for a percentage of the claim
- Some agents are willing to play the numbers game—lodge poor applications in the knowledge that the regulator doesn't have the budget to audit all claims.

Policy changes

Most participants were not in favour of changes to the policy.

- Changes in policy makes investment decisions difficult as it creates uncertainty. Firms can't incorporate the programme into long term planning with that uncertainty.
 - Look at how the policy changes in 1996 affected registrant numbers.
- Any policy changes need to be well thought out, enduring and with a strong rationale.
- OECD has noted the importance of stability in these types of policies.

Despite the desire not to change the policy, some suggestions were raised to improve the programme:

Quarterly payments

A suggestion that quarterly payments be made was raised several times. The Department has already done the work to design the process, including consultations, but it was never implemented due to a change in government. Quarterly payments would definitely help with cash flows—particularly for start-ups. Without quarterly payments, an industry is growing to provide R&D financing (loans collateralised on R&D TI), including:

- Rocking Horse Ventures (<http://rockinghorsegroup.com.au/>). Rocking Horse Ventures charge 15 of the tax offset/refund and have to pay 10% to their lenders.
- Metamor Capital Partners (<http://www.metamorcapital.com/>)
- Macquarie Bank Ltd
- TCF Services Pty Ltd (<http://www.tcf.net.au/>)

Above the line accounting

Enabling ‘above the line’²⁶ accounting treatment of the benefit was noted several times as a potential improvement, however, there was some disagreement about the feasibility of this.

Above the line treatment of the tax credit would help attract innovation by making the benefit more visible. Currently, expenses associated with the R&D are above the line but the benefit is below the line. It was noted, though, that this would help but not be a ‘make or break’ issue for investment decisions.

There are conflicting opinions on whether this is a problem:

- Some argue that the only resolution is a change to international accounting standards
- Others say the 45% refund can be above the line now (if treated as a grant), but not the tax credit
- Others say it is not an issue and can be reported above the line now.

France and the UK have found ways to put the treatment above the line without changing accounting standards.

More targeting

Many stakeholders suggested that the programme could be improved by targeting the benefits towards particular groups. Often these groups aligned with the interests of the particular stakeholder making the suggestion. The suggested changes were:

- A ‘super-rate’ for public-private collaboration, provides the incentive to the partnership rather than the firm or the university. Universities have equipment and expertise but not applying it productively. Better than grants that are ‘picking winners’
- Reduce the 45% rate to 40% and broaden the definition to innovation to reach more firms, or provide more funding to larger firms
- Extend the programme beyond corporations to trusts (which often effects farmers and vigneron) and NFPs (as noted previously for CRCs)
- Provide extra funding for R&D in research priority areas, sectors, firms or projects.
- Give more to small firms because they generate more additionality/spillovers, take it off larger firms if needed
- target those who need it—smaller and newer firms—rather than targeting sectors and picking winners
- Take funding from big business and give it to start-ups

²⁶ The ‘line’ generally refers to gross profit. Above that line on the income statement, typically, are sales and COGS (cost of goods sold) or COS (cost of sales or cost of services). Below the line are operating expenses, interest, and taxes. Items listed above the line tend to vary more (in the short term) than many of those below the line, and so tend to get more managerial attention.

However, many didn't support these types of changes:

- The current policy, without much targeting, is simple, low cost and could provide stability and certainty.
- Targeting can be political and leads to frequent changes
- New rules and thresholds will be too difficult to implement and add to compliance cost thereby decreasing effectiveness/attractiveness
- There is no evidence (or at least nothing deemed credible) to support cutting the incentive for large firms

Expenditure cap

There were mixed views about the impact of the new \$100m R&D expenditure cap.

- Some reported that it didn't have an impact because the R&D TI is not a major consideration for those large firms.
- Other views were that introducing the cap means larger firms are definitely not considering the R&D TI. It is not driving any behavioural change once the R&D budget rises above \$100m. It may be having a negative effect on R&D as there is no longer an incentive to conduct those projects in Australia.

Some participants noted that the policy change was rushed, not consulted on, and not properly considered, there was no evidence to support it.

It was suggested that the \$100m expenditure cap be flexible, for example, be waived or raised on application.

At the other end of the spectrum, the \$20k expenditure threshold was noted as a deterrent to small agriculture firms participating in the programme on their own. Many agriculture projects are small such as improving best practice management on farm.

Others considered the \$20k cap immaterial in companies' thinking. RSPs (e.g. CSIRO) didn't consider its waiving a selling point.

Grouping rules

Current grouping rules make it difficult for some start-ups. If a firm has majority ownership by a larger firm or university (e.g. university spin-off) then they can't access the 45% refund due to the grouping rules. For start-ups, this is often a key time where they are looking for more investors but the initial investor is large and leads to disqualification from the programme. A possible solution might be increasing the ownership limit for university spinouts to 51%.

A hypothetical anomaly was noted where a start-up was owned equally by three large MNCs. As no one MNC has greater than 33% ownership, the grouping rules would not apply and it would be eligible for 45% rate.

A slightly related issue is that firms need to be eligible for the entire tax year for any claim to be lodged. This can materially affect start-ups if they become eligible part way through the year (by getting more investors and therefore being classified as an eligible

small firm). In these circumstances, the firm is not able to make use of the R&D TI until the next financial year.

RSP programme/collaboration

Generally, there was limited awareness of the RSP programme. Some firms were collaborating yet were not aware of the RSP programme. Others said the RSP programme helps support the R&D TI claim but it was not really a driver for collaboration. It was noted that waiving the \$20k threshold doesn't make a difference as it is not worth claiming the Incentive at that level anyway.

Most stakeholders agreed that collaboration should be increased and there were varying views about why collaboration isn't occurring and how to encourage it.

- Big firms look in-house for expertise rather than collaborating.
- Collaboration is a cultural issue that needs to be fixed in firms, not universities.
- Universities are driven by 'publish or perish' motives. The funding formula for public institutions needs to be based on impact, not citations.
- Collaboration is usually driven by: familiarity with the university, background of the researcher, reputations, facilities/capabilities, matching timeframes and expectations
- IP ownership has always been an issue (particularly with CSIRO)
- Collaboration could be encouraged if the R&D TI was only received over a threshold if some of the R&D is with an RSP
- Paying RSPs using credits (similar to the Victorian programme) could increase collaboration
- The CRC programme has seen benefits for collaboration, with PhD students going back to industry.
- The high-end medical sector use the RSP element of the programme

Monitoring outcomes

Several stakeholders agreed that information on the benefits of the programme would be valuable, yet most agreed that they did not want to increase the administrative burden through extra data collection. Additionally, there was concern that information collected would not end up being used effectively. Need to make the most use of the data already collected and only collect what will be used.

- In the past, recipients were required to report on outcomes of R&D (including anticipated outcomes and progress reports) in the registration process. This was raised as a possibility but there were compliance cost concerns and a concern that information collected would not be used (and therefore a net burden).
- Could measure outcomes by the number of products commercialised, yet this is not a comprehensive picture of the outcomes of the programme.
- Questions could be added to the current ABS survey to minimise extra burden.

Definition

The definitions used in the policy were raised several times as an issue for some businesses. Generally the feedback was that the current definition and terminology was too scientific and does not suit commercial approaches and thinking. Given that, it is difficult for firms to substantiate or provide evidence. This difficulty adds to the compliance costs of the programme.

More specifically comments included:

- Definitions that put science in a box don't work
- The definition should be written in 'business language'
- The term 'dominant purpose' is unclear with no explanation
- The distinction between core and supporting R&D is costly to identify/justify yet the benefit in terms of tax credits is the same
- Business definition of R&D differs from that of the government
- The new definition under the Incentive is better than the old definition under the Concession

One participant raised an issue about unclear treatment of marketing expenditure.

- It should be excluded, but testing a value proposition requires marketing and is a key part of the development process. This is an issue in the software development space (most digital start-ups).
 - There was disagreement among fellow participants as to whether this was an issue.

Two regulators

Most stakeholders expressed little issue with having two regulators (AusIndustry and the ATO).

However, some issues were raised:

- Firms face different timeframes for registration and the ATO tax returns
- Regulators shouldn't examine expenditure separate from activities
- Having two regulators is not efficient, other countries just have one
- If there is only one regulator, preference would be for it to be the Department of Industry, Innovation and Science, not Treasury

Other issues raised in this space included:

- whether it would be possible to register once for multiple year projects, or have some simplified registration process for returning registrants

Other policies

Many stakeholders noted the importance of the wider policy environment to R&D. There are currently many different programs at State and Federal levels (up to 150) but they

are disconnected and there is limited awareness of them. The policies should be streamlined, focused and linked.

Some stakeholders noted that there is **not a better policy option** than the R&D TI and that it should be supported further (including better promotion) rather than introduce new policies. The R&D TI is supported because it doesn't pick winners, is available across the economy, relies on self-assessment rather than potentially capricious competitive grant programmes, there is greater certainty in the expected benefit rather than the uncertainty of costly grant applications, the system is working well and it encourages spending (i.e. it is not a handout).

A number of stakeholders raised the need to better **support commercialisation** as well as maintaining the R&D TI. Suggestions to achieve this include the patent box and an innovation incentive, providing preferential tax treatment on profits from a commercialised innovated process/product.

The **company tax rate** is a major policy lever that has been raised as an alternative mechanism to encourage investment. However, this is only relevant for firms that are in profit; pre-revenue firms are not affected by company tax rates.

Grant programs are usually raised as the obvious alternative policy vehicle. Most noted, however, that grants are expensive and leads to considerable effort being applied to obtain the grant rather than conducting the R&D. For example, the Export Market Development Grants are ridiculously hard to obtain for the eventual pay off. Comparatively, the R&D TI is simple and straight forward.

Grants were supported as a complementary policy to the R&D TI. They may be suited to a start-up where someone has been working on their own without paying a salary and therefore don't have many R&D expenses. Grant programs are consistent with an observed shift overseas towards more **direct** (rather than indirect) funding (e.g. Innovate UK – specific agencies to target funding). In this context, the US' SBIR program (and the UK equivalent) were cited several times throughout the stakeholder meetings as a good idea.

A **patent box** was the other common alternative/supporting policy raised. The UK and Ireland have implemented patent boxes and some agents have advised their clients to move to Ireland to make use of the incentive. The advantages of patent boxes are that they could (depending on design) keep IP in Australia and support employment and job creation. However, some participants also raised concern with the patent box option, primarily in the digital sector as patents are not suited to the sector. If patent boxes were pursued, the preferred approach is that of the updated UK approach where the research must be conducted in the country.

As part of fixing the wider policy environment, it was suggested that **Venture Capital policies** should be looked at. The policy environment needs to provide flexibility, change business failure laws, and tax write offs. The current culture doesn't support failure, the country is very risk adverse approach to bankruptcy, insolvency (and trading your way out of it), directors liability, loss carry-back, etc.

List of organisations invited to consultation

Table D.1 Groups invited for consultation

Organisation	Participating representative
Innovation Australia and R&D Incentives Committee	Dr Marlene Kanga David Wilson Steven Green Kathryn Adams Dr Lisa Springer Dr Bruce Godfrey Marty Gauvin Julie Phillips
Chief Scientist	Professor Ian Chubb
Tax agent—KPMG	David Gelb
National Reference Group (NRG)	Jason Dunnachie and Karen Stein, R&D and Government Incentives, Deloitte Dr David Gelb, Lead Partner, R&D Incentives, KPMG Ms Sandra Boswell, Partner and John Polack, PricewaterhouseCoopers Mr Jamie Munday, Partner, Strategic Growth Markets, Ernst & Young Mr Kris Gale, Managing Director and Melanie Reen of Michael Johnson & Associates Mr David Fox, Consultant, Corporate Tax Association (CTA) Mr Leigh Conlan, CPA Australia Ms Donna Bagnall, Senior Tax Consultant, Institute of Chartered Accountants in Australia (ICAA) Dr Margaret Hartley, CEO, and Matt Wenham, Academy of Technological Sciences and Engineering (ATSE) Mr Paul McMullan, Director of Compliance Group Limited
Tax agent—Deloitte	Jason Dunnachie and Karen Stein
Peak industry association—Ai Group	Mr Innes Willox Tennant Reed Pip Freebairn Peter Burn
Peak industry associations—Melbourne group meeting	Suzanne Roche (AIIA) Jarrod Ball (BCA) Ken Mirams, Australasian Industrial Research Group (AIRG) John Pollaers & Jennifer Conley, Australian Advanced Manufacturing Council (AAMC) Kathryn Howley, Plastics and Chemicals Industries Association (PACIA) Ben Stapley, CEO, Australian Dairy Farmers
Peak industry associations	Tony Weber CEO and Tony McDonald Director Industry Operations, Federal Chamber of Automotive Industries (FCAI)
Peak industry associations	Brendan Pearson, Chief Executive, Minerals Council of Australia
Research organisation—Universities Australia	Belinda Robinson, Chief Executive; Mark Warburton, Principal Analyst; and Sarah Brown, Policy Director—Research
Peak industry	Martin Snoke, Medicines Australia

Organisation	Participating representative
associations—Sydney group	Susi Tegen, Medical Technology Association of Australia (MTAA) Dougal Gordon, Australian Lot Feeders' Association (ALFA) James Matthews, Australian Food & Grocery Council (AFGC) Christine Gibbs Stewart, CEO, Austmine Renee Hindmarsh, Australian Technology Network (ATN) Robert Newton, Energy Pipelines CRC Ltd, University of Wollongong
Middle-tier tax agents	Tracey Murray, Griffith Hack Consulting Sukvinder Heyer, Grant Thornton Australia Graham Wakeman, BDO Australia Sameer Kassam, CharterNet Services Andrew Hills, NOAH Consulting Michael Ronai, Ronai & Associates Tom Parkhouse, SR Tax Services Adam Alexander, Crowe Horwarth Callan Rogers, Inventure Partners Tim Joyce, Reed Management Consulting t/a Insight Business Stephen Carroll, RSM Bird Cameron Claire Thomson, BSI Innovation Mick Lynch, BSI Innovation Nicola Purser, BDO (Qld) Ross Patten, RADBE Consulting Christopher Buck & Neil Covey, Export & Industrialisation Advisory Corp
Venture capital and start-ups	Dr Robert Daniels, CEO, Elastagen Sebastien Eckersley-Maslin and Luther Poier, BlueChill Brigitte Smith, GBS Venture Partners Kar Mei Tang, AVCAL Elaine Stead, Blue Sky Ventures Rick Baker, Blackbird Ventures
Research organisation—CSIRO	Mr Jack Steele, CSIRO
Tax agent—Ernst & Young	Jamie Munday
Tax agent—Michael Johnson & Associates	Sarah Lander (Partner) Ian Ross-Gowan (Director)
Tax agent—PricewaterhouseCoopers	Sandie Boswell
Peak industry association—Agribusiness Council of Australia	Roy Duncanson, Agribusiness Council of Australia
Peak industry association—Association of Mining & Exploration (AMEC)	Simon Bennison, Association of Mining & Exploration (AMEC) +6
Peak industry association—AusBiotech	Dr Anna Lavelle, AusBiotech
Large company	Gavin Smith, President, RBA

Organisation	Participating representative
- Robert Bosch (Australia)	Mounir Kiwan, Corporate Affairs Manager, RBA

Source: Department of Industry, Innovation and Science

E Survey methodology

The process of conducting the survey provided some important insights into the programme. These insights are relevant to understanding how the R&D TI is used and perceived by recipients.

Questionnaire design

Drawing the lessons from the 2003 R&D Tax Concession Survey, the CIE, with close consultation with the Department and ABS Statistical Clearing House, developed a comprehensive 36-question survey questionnaire.

Several principles have been followed in the process of designing the questionnaire:

- the number of questions should be kept to the possible minimum to reduce the burden on respondents and to increase the response rate
- the questions should be easy to understand
- the focus of the survey questionnaire should be about firms' behaviour change caused by the R&D Tax Incentive programme, and
- while keeping the first principle in mind, the questionnaire should have some flexibility for the analysts to check the consistency of answers provided by respondents to different questions

Three major drafts of questionnaire were produced before it was piloted, which resulted the reduction in the number of questions from more than 50 to 36, and a significant change in the flow of questions. The responses to the pilot survey led to some minor changes in the questionnaire, mostly changes in wording.

The final version of the questionnaire grouped 36 questions into 7 sections:

- General information about firm or business
- The purpose of R&D
- The drivers of R&D including the criteria for R&D decision making and factors preventing the firm from doing more R&D in Australia
- R&D inputs including the cost structure, the change in demand in response to cost reduction, sources of R&D knowledge, and external collaboration
- The impact of R&D Tax Incentive on firm's R&D, the compliance cost, and the guidance material
- The consequences of R&D including the novelty of R&D outcomes, successful rate, duration of research projects, protection of R&D outcomes, and private benefits from R&D

- Wider impacts of R&D including how soon for competitors to catch up and how easy for them to copy the firm's R&D, and other spillover impacts on the wider community

The full questionnaire is provided in Appendix F.

Sampling

Initially we intended to include in the survey frame all firms/businesses that had ever registered under the R&D TI. However, taking into consideration of the fact that some firms might be closed or merged into other organisations (and therefore not contactable) we excluded those entities who registered in the financial year of 2011–12 only but not in any of the later years.

This resulted in 15 810 R&D entities being included in the population frame, of which 1779 are large with annual R&D expenditure over \$2 million, and 14 031 are small and medium entities (SMEs). The classification of large and SME according to R&D expenditure is due to the fact that the turnover data in the database is for aggregated group, rather than for individual R&D entity.

Because the number of large entities is relatively small, and their R&D expenditure accounts for more than three quarters of total R&D expenditure a census of these firms was conducted (that is, every large R&D entity in the frame was included in the survey). Table E.1 reports the sectoral distribution of large R&D entities by the number of entities and by the amount of R&D expenditure.

Table E.1 Sectoral distribution of large R&D entities in the population

Industry	Number of Entities	R&D expenditure	Average R&D expenditure	Entities share	R&D expenditure share
–	–	\$m	\$000	%	%
Ag	75	461	6,144	4.22	2.05
Mining	294	5,572	18,951	16.53	24.74
Manuf	525	6,823	12,996	29.51	30.30
Utilities	69	760	11,008	3.88	3.37
Construction	88	841	9,552	4.95	3.73
Wholesale	18	148	8,216	1.01	0.66
Retail	25	303	12,128	1.41	1.35
AccomFoodSrv	3	18	5,960	0.17	0.08
Transport	27	468	17,341	1.52	2.08
ICT	183	1,367	7,471	10.29	6.07
Finance	79	2,493	31,554	4.44	11.07
RentalHireRE	5	47	9,392	0.28	0.21
ProfSciTecSrv	319	2,677	8,391	17.93	11.89
AdminSupportSrv	12	63	5,262	0.67	0.28
PublicAdmSafety	6	87	14,536	0.34	0.39
Education	6	33	5,482	0.34	0.15
HealthSocialSrv	24	147	6,124	1.35	0.65
ArtRec	9	115	12,734	0.51	0.51
OthSrv	12	97	8,084	0.67	0.43
Total	1779	22,518	12,658	100.00	100.00

Note: Industry is defined as the Industrial Division in Australia New Zealand Standard Industrial Classification (ANZSIC)

Source: R&D TI database

A stratified random sampling is applied for SMEs. Taking into consideration of a targeted confidence level and response rate, 2211 SMEs were included in the survey. The number of SMEs in the sample was allocated to each industry according to their distribution in the population, and the particular SMEs in an industry were selected randomly. Table E.2 reports the sectoral distribution of SMEs by the number of entities and by the amount of R&D expenditure in the population, while Table E.3 reports their distribution in the survey sample.

Table E.2 Sectoral distribution of SMEs in the population

Industry	Number of entities	R&D expenditure	Average R&D expenditure	Entity share	R&D Expenditure share
–	–	\$m	\$000	%	%
Ag	513	243	473	3.66	4.01
Mining	680	421	618	4.85	6.95
Manuf	4678	1,970	421	33.34	32.58
Utilities	334	137	411	2.38	2.27
Construction	414	186	450	2.95	3.08
Wholesale	228	76	332	1.62	1.25
Retail	188	64	340	1.34	1.06
AccomFoodSrv	31	11	341	0.22	0.17
Transport	159	78	493	1.13	1.30
ICT	2692	1,134	421	19.19	18.75
Finance	249	129	518	1.77	2.13
RentalHireRE	84	37	439	0.60	0.61
ProfSciTecSrv	2978	1,255	421	21.22	20.76
AdminSupportSrv	127	47	369	0.91	0.78
PublicAdmSafety	23	13	547	0.16	0.21
Education	152	59	385	1.08	0.97
HealthSocialSrv	280	108	386	2.00	1.79
ArtRec	65	26	397	0.46	0.43
OthSrv	156	55	353	1.11	0.91
Total	14031	6,047	431	100.00	100.00

Note: Industry is defined as the Industrial Division in Australia New Zealand Standard Industrial Classification (ANZSIC)

Source: R&D TI database

Table E.3 Sectoral distribution of SME samples

Industry	Number of Entities	Total R&D expenditure	Average R&D expenditure	Entities share	R&D expenditure share
–	–	\$m	\$000	%	%
Ag	80	39	482	3.62	3.83
Mining	107	74	696	4.84	7.40
Manuf	728	313	430	32.93	31.13
Utilities	51	18	360	2.31	1.83
Construction	61	28	457	2.76	2.77
Wholesale	35	11	316	1.58	1.10
Retail	31	11	364	1.40	1.12
AccomFoodSrv	5	1	153	0.23	0.08
Transport	25	12	492	1.13	1.22
ICT	427	196	460	19.31	19.53
Finance	42	21	496	1.90	2.07
RentalHireRE	13	8	603	0.59	0.78
ProfSciTecSrv	475	217	457	21.48	21.56
AdminSupportSrv	21	11	525	0.95	1.10
PublicAdmSafety	4	4	1,036	0.18	0.41
Education	25	10	384	1.13	0.95
HealthSocialSrv	45	19	413	2.04	1.85
ArtRec	11	5	431	0.50	0.47
OthSrv	25	8	326	1.13	0.81
Total	2211	1,006	455	100.00	100.00

Note: Industry is defined as the Industrial Division in Australia New Zealand Standard Industrial Classification (ANZSIC)

Source: R&D TI database

Pilot survey

A pilot survey was conducted for 100 entities to test the design of questionnaire and the functionality of web-based survey form. Some minor changes were made to the questionnaire and the web-based form as a result of the pilot survey.

Full scale survey

The full scale survey involved these steps:

- identify the most relevant and workable emails for all large entities and firms in the SME sample
- send out pre-approach emails by AusIndustry to survey recipients notifying them of the survey

- send out survey email with unique web link to survey form for each survey recipient by the survey company
- follow up emails to remind survey recipients to complete the survey, and
- respond to queries from survey recipients.

A top-up strategy was also developed for the case where the required response rate of SMEs was below the targeted 20%. New samples would be drawn according to the industrial stratification. If the response rate within an industry was below 20%, then more samples would be selected using the same process as the first sampling process.

F Survey questionnaire

About your firm or business in general

[NOTE: Comments in square brackets after questions are coding instructions]

General notes

Please note that the questions in this survey refer to the specific R&D entity which applied for the R&D Tax Incentive, not the whole group the R&D entity may be associated with.

If you are listed as a contact person for a group of companies, you may have received more than one email containing a unique web link for each specific entity within that group. If this is the case, please provide responses for each specific entity using the specific web link that was emailed to you.

Business details

The following questions are designed to provide us with some general information about your firm.

First, we need to confirm the business entity for which we would like to receive responses. The information below has been drawn from the AusIndustry database and sets out key registration details. Please amend the details if they have changed since your original application.

- 1 Your organisation number assigned by AusIndustry: ____ [Response to be pre-populated from sample database]
- 2 Your Australian Business Number (ABN): ____ [Response to be pre-populated from sample database, but with the opportunity for the respondent has the to amend or to add if the ABN was not provided in the original application]
- 3 Your R&D entity name: _____ [Response to be pre-populated from sample database, but with the opportunity for the respondent has the to amend or to add if the name was not provided in the original application]

- 4 Is your R&D entity publicly listed?
[Choose from dropdown list of 'yes' and 'no']

Turnover, sales and employment

We are interested in the turnover, sales and employment for the specific entity identified in the previous questions.

If exact data are not available, please provide your best estimate.

- 5 In 2013–14, what were the turnover (total revenue) and taxable income or loss for your business?

Turnover: \$ _____
Taxable income/loss (+/-): \$ _____

- 6 In 2013–14, what percentage of your sales went to the following categories:

Category	Share of sales (%)
Australian retail (household) customers	
Australian wholesale (business) customers	
Exports	
Total	[Webform to provide running total to ensure sum is 100]

- 7 What was the total employment of your business in 2013–14? Please include permanent, part time and casual workers, but not contractors. Please express this employment in terms of full time equivalent (FTE) workers.

Total employment in 2013–14? _____ persons (FTE)

What percentage of these workers held tertiary (university level) qualifications or had an equivalent skill level? _____%

Overseas R&D

- 8 How much (if any) of your total R&D spending was conducted overseas (as a percentage of total R&D) in 2013–14? _____%

The purpose of your R&D

- 9 Thinking about your total R&D expenditure on average over the past 5 years (not in any particular year), what proportion of your R&D expenditure is targeted towards the following broad purposes?

Targeted outcome or purpose			Share of total R&D spending (%)
Product or service	For sale to final household consumers (retail sales)	New	
		Improvement in existing	
	For sale to other businesses (wholesale)	New	
		Improvement in existing	
Production process	For use in own production facilities	New	
		Improvement in existing	
	For sale or licensing to other firms	New	
		Improvement in existing	
TOTAL			[Webform to provide running total to ensure sum is 100]

The drivers of your R&D

- 10 Which one of the following options best describes your approach to determining your level of R&D spending? Select the most appropriate option.

Criteria	Selection
A: No formal criteria: R&D spending is opportunistic	
B: R&D spending is set (roughly) at a fixed proportion of revenue or turnover	
C: R&D spending is determined through reference to specific investment criteria	

[If the respondent chose C, proceed to question 11. Otherwise proceed directly to question 13.]

- 11 What criteria do you use when deciding whether or not to proceed with an R&D project? Please indicate the criteria used, as well as the appropriate threshold for that criteria.

Criteria	Tick if criteria is used	Threshold value for criteria
A: Hurdle rate of return (the minimum rate of return you require for investment in R&D)		%
B: Benefit–cost ratio		:1 ratio
C: Minimum payback period		years
D: Other (please specify)		

- 12 The framing of this question depends on the response in question 11.

If the hurdle rate of return (A) was chosen then:

If management were to lower the hurdle rate of return on R&D by 5 percentage points (e.g. from 15% to 10%, or from 10% to 5%), then approximately how much more R&D would your firm undertake? _____%

If the benefit–cost ratio (B) was chosen then:

If management were to halve the required benefit–cost ratio (e.g. from 10:1 to 5:1), then approximately how much more R&D would your firm undertake? _____%

If the minimum payback period (C) was chosen then:

If management were to double the minimum payback period (e.g. from 5 years to 10 years), then approximately how much more R&D would your firm undertake?
 _____%

If 'other' was chosen (D), then proceed directly to question 13.

- 13 If you had more funds available for R&D, what would you spend them on? For every additional dollar you spend on R&D, what proportion of that spending would go to each of the following options?

Option	Proportion of additional spending (%)
Extension of current projects	
Development of new projects	
TOTAL	[Webform to provide running total to ensure sum is 100]

- 14 Thinking about your total R&D expenditure, please indicate the importance of the following factors as constraints to your firm undertaking additional R&D spending in Australia. Rate the importance from 1 to 5, where 1 is not important, 2 is somewhat important, 3 is moderately important, 4 is very important and 5 is extremely important.

Factor	1—not important	2—somewhat important	3—moderately important	4—very important	5—extremely important
Opportunity and motivation					
Limited technical opportunities for the R&D to target					
Limited opportunity to market and sell new products, services or processes that may emerge from R&D					
There are more profitable R&D opportunities overseas					
R&D too risky to undertake in Australia					
It is too hard to keep the returns from R&D investments (for example, competitors will catch up to quickly)					
The returns from additional R&D are lower than sufficient to justify the investment					
Resource availability					
Limited availability of capital to fund R&D					
Limited availability of skilled technical workers to undertake the R&D					

Limited availability of appropriate research collaborators					
Limited availability of technical or specialist equipment used in undertaking the R&D					
Government constraints					
Company tax rate too high					
Regulations (e.g. occupational health and safety or environmental regulations) restrict ability to undertake R&D					
Labour market regulations make it hard to employ workers for R&D					
Cost of obtaining patents or other form of intellectual property					
Inadequate protection of intellectual property					
Other (please specify) _____					

Your R&D inputs

- 15 What is your current break up of your R&D spending? *Please use approximate figures if exact numbers are not available.*

R&D cost item	Current share in total R&D costs (%)
Rent, buildings, plant and machinery	
Skilled labour	
Feedstock	
Other general material inputs	
Specialised technical or laboratory equipment	
Cost of collaboration with other firms or researchers	
Contracted out R&D	
Purchase of rights to intellectual property/licensing cost	
Other (please specify)_____	
TOTAL	[Webform to provide running total to ensure sum is 100]

- 16 Hypothetically, if the cost of various items making up total R&D expenditure were reduced by 20%, how much would your spending on these items change? *Please provide your best estimate.*

R&D cost item	Increase in use of item following a hypothetical 20% reduction in the cost of the item (%)
Rent, buildings, plant and machinery	
Skilled labour	
Feedstock	
Other general material inputs	
Specialised technical or laboratory equipment	
Cost of collaboration with other firms or researchers	
Contracted out R&D	
Purchase of rights to intellectual property/licensing cost	
Other (please specify) [INSERT 'other' response from previous question (15)]	

17 Please rate the importance of the following as sources of inputs to your R&D activities

Factor	1—not important	2—somewhat important	3—moderately important	4—very important	5—extremely important
R&D undertaken by other organisations in Australia					
R&D undertaken by other organisations in your industry or sector					
R&D undertaken by other organisations in your region					
R&D undertaken by other organisations overseas					
Own R&D undertaken previously					

18 Please rate the importance of the following external (outside of your company) sources of R&D information to the conduct of your R&D activities

Factor	1—not important	2—somewhat important	3—moderately important	4—very important	5—extremely important
Purchase or licensing of intellectual property					
Merger with, or acquisition of, firm owning R&D intellectual property					
Movement of staff from other organisations to your organisation					
Explicit collaboration with other firms					
Contracting of R&D activities					
Access to key publications or published patent information					
Networking amongst researchers					
Use of open source information					
Other (please specify) _____					

19 Do you have experience working with external researchers (including Research Service Providers, RSPs, registered with Department of Industry and Science)? Please indicate as appropriate.

Use of external researcher	Selection
Used external researcher	
Used external researcher that was a registered Research Service Provider	
Did not use external researcher	

[If either or both of the first two options above are selected, proceed to question 20, otherwise proceed to question 22].

20 Which of the following best describes your view about the scope to increase the level of collaboration between industry and researchers? Please choose **one** item from the following list:

Option	Selection
There are a large number of highly valuable opportunities for more collaboration with external researchers	
There are a few but highly valuable opportunities	
There are many small value opportunities	
There are few small value opportunities	
There are no obvious opportunities	
We are yet to explore the extent of these opportunities	

21 In your firm's experience, to what extent do the following factors represent a barrier to collaborating with external researchers (including Research Service Providers, RSPs, registered with Department of Industry and Science)? Please rate each item.

	1—not a barrier	2—A small barrier and easily overcome	3—Significant barrier but can be readily overcome	4—Large barrier and not easily overcome	5—Large barrier and cost of overcoming outweighs the benefit
External researchers have different objectives for R&D activities					
Cultural differences between your organisation and potential research partners					
Differing expectations on timing for delivery of the R&D					
External researchers have limited capacity to assist with R&D activities due to lack of facilities or specialist equipment.					

	1—not a barrier	2—A small barrier and easily overcome	3—Significant barrier but can be readily overcome	4—Large barrier and not easily overcome	5—Large barrier and cost of overcoming outweighs the benefit
External researchers have limited capacity to assist with R&D due to lack of specialist knowledge or experience					
Intellectual property issues					
Your business is unsure of the potential benefits of conducting using external researchers to undertake R&D					
Your business is unaware of the external research services being offered					
Lack of funds limits the ability to employ external researchers					

How does R&D tax policy affect your R&D?

We need to understand how government policy in general, and the R&D Tax Incentive in particular affect your R&D investment decisions. *If exact data are not available please provide your best estimate.*

- 22 How much of your total R&D expenditure has been influenced by, or determined by, the existence of the R&D Tax Incentive? Please indicate the proportion of total R&D spending that falls into the following categories.

Category	Proportion of total R&D spending (%)
R&D Tax Incentive did not influence R&D spending	
R&D Tax Incentive was considered, but did not change the decision to fund R&D	
R&D Tax Incentive was considered and materially influenced the decision to fund the R&D	
Total	[Webform to provide running total to ensure sum is 100])

- 23 On average, what are the annual compliance costs incurred (including a value of time taken) by your company in applying and claiming for the R&D Tax Incentive?

Please only consider the additional compliance costs associated with the R&D Tax Incentive itself. Although the R&D Tax Incentive is associated with your tax return, we do not want you to include the full compliance cost of lodging a tax return — only that proportion specifically associated with the R&D Tax Incentive.

Compliance cost item	Annual cost (\$)
Application and registration of R&D activities	
Inclusion of R&D activities in tax return (e.g. if a consultant is used to lodge tax return, extra fee charged by the consultant due to the additional requirement to comply with R&D Tax Incentive program)	
Record keeping and other post-application compliance activities	
Other	
Total	[automatically calculate the total]
Of this total, how much was paid to a tax agent or other consultant?	\$

- 24 In your opinion, to what extent was the guidance material available through AusIndustry and the ATO of use in accessing and understanding the R&D Tax Incentive? Please select one of the following

Option	Selection
1 – little or no use	
2 – somewhat useful	
3 – moderately useful	
4 – very useful	
5 – extremely useful	
Not aware of the material	

The consequences of your R&D

- 25 What percentage of your total R&D spending results in products, services, processes or platform technologies that are new to your industry, new to Australia, or new to the world? Please indicate as appropriate.

Level of novelty	% of total R&D
New to your industry	
New to Australia	
New to the world	

- 26 What proportion of your R&D projects (in terms of the number of projects) proceed through to final commercial success? Please provide an indication for the following stages.

Stage	Proportion (%)
Proportion of projects that are a technical success	% of total R&D projects
Of the technically successful projects what is the proportion that proceed to commercialisation?	% of technically successful projects
Of projects that proceed to commercialisation what is the proportion that are a commercial success.	% of projects proceeding to commercialisation stage

- 27 What is the average period of a R&D project from initiation to commercial success?
Please provide an indication for the following stages.

Stage	Average time per stage (Years)
Technical research	
Commercialisation	
Total	(automatic calculation)

- 28 Is your R&D outcome protected from being copied by any of the following? Indicate as many as appropriate.

Form of IP protection	Selection
Patent(s) registered in Australia	

Patent(s) registered overseas	
Other IP rights including licensing and plant variety rights	
Ownership or rights to dedicated natural resource	
Ownership or rights to key technological input	
Ownership or rights to other essential inputs	
Production process too complex to be copied by competitors	
Secrecy of R&D outcomes	
High investment required to replicate	
Dedicated client base (specifically targeted clients)	
Quick speed to the market so that competitors have no time to copy	
Other, please specify	

- 29 What rate of return or benefit–cost ratio is typical for a commercially successful R&D project in your firm?

Rate of return _____%

or

Benefit–cost ratio: _____:1 (benefit:cost)

- 30 We are interested in understanding the potential impacts of your R&D in a typical year 5 years after completion of the R&D.

How much higher do you think your domestic sales, export sales and profit will be after 5 years as a result of the R&D you conduct in a typical year? We understand that exact answers will not be possible—please supply your best estimates from the drop down list provided

Each cell to contain a drop down list of options: 1) 0%; 2) 1–5%; 3) 6–10%; 4) 11–15%; 5) 16–20%; 6) 21–25% and 7) >25%; and please specify the increase if you choose >25%

Impact item	Change (%)
Domestic sales (sales within Australia)	+/- % (default is +)
Export sales	+/- % (default is +)
Profit	+/- % (default is +)

How much lower do you think your cost of production will be after 5 years as a result of the R&D you conduct in a typical year?

[Use same drop down list]

Impact item	Change (%)
Cost of production	-/+ % (default is -)

Wider impacts of your R&D

31 On average, how long after commercialisation of your R&D do your competitors catch up with you (that is, you lose the competitive edge provided by the R&D)?
 ____ years

32 At the current level of protection of your intellectual property, how easy do you think your R&D outcomes can be copied, implemented by your competitors, or applied by other industries? Please rate.

Factor	1—impossible	2—possible, but with some difficulty	3—somewhat easy	4—moderately easy	5—very easily
Copied by competitors					
Applied in other industries					

33 Please indicate if there have been any other significant effects of your R&D that have impacted other firms. Indicate the size of the effect using the rating indicated.

Area of impact	1—no impact	2—minor impact	3—moderate impact	4—high impact	5—very high impact
Safer working environment					
Reduced pollution					
Reduced company/industry risk					
Increased skills of employees					
Development of a new or improved platform technology					
Other (please specify)					

34 Do you have any further comments on the R&D Tax Incentive program or any suggestions on how the program could be improved?

[Response in text box]

35 If you are willing to be contacted to clarify some aspect of your responses, please provide your contact details. This information is optional.

Your name: _____

Your current position: _____

Best contact email: _____

36 Please indicate how long it took you to complete this survey _____minutes

G R&D model

Central to this review is the estimation of the additional R&D done by companies in response to the tax incentive. The CIE developed, for analysis of the R&D Tax Concession in 2003, an economic model of R&D to estimate the additional R&D induced by government R&D policies.

The model allows different ways of utilising the information from the survey to estimate the additionality. In this appendix a brief introduction is given to each of these approaches from simple to more comprehensive ones.

Direct method

R&D expenditure (E) can be broken into several components: rent of building or plant-machinery (K), skilled labour (L), feedstock (F), general inputs and materials (M), specialised technical or laboratory equipment (T), collaboration cost (C), contracted out R&D (U), purchase of property rights (R) and other inputs (O):

$$E = K(P_K, P_{-K}) + L(P_L, P_{-L}) + F(P_F, P_{-F}) + M(P_M, P_{-M}) + T(P_T, P_{-T}) + C(P_C, P_{-C}) \\ + U(P_U, P_{-U}) + R(P_R, P_{-R}) + O(P_O, P_{-O})$$

where P_i is the price of individual input, $i \in \{K, L, F, M, T, C, U, R, O\}$; and P_{-i} is prices of inputs other than i . The extra R&D expenditure induced by tax incentive is

$$\sum_{i \in K, L, M, T, C, O} \sum_{j \in K, L, M, T, C, O} \varepsilon_{ij} s_i$$

where t is the R&D Tax Incentive, ε_{ij} is the elasticity of demand for R&D component i with respect to the change in the price of component j , and s_i is the share of component i in total R&D expenditure.

Own price elasticities and cost shares are given by questions 15 and 16 directly. However, it is more difficult to determine the cross elasticities. A simplification is to assume there is no substitution between individual inputs. This leads to

$$AR^A = \sum_i (s_i \varepsilon_i)$$

The results of this approach are given under 'Direct method (A)'. Because cross price elasticities usually have opposite sign to own price elasticities, assuming no substitution would in general overstate the inducement effect.

Simple model

Taking consideration of the answers to the influence of R&D Tax Incentive programme

The calculation using the Direct Method gives the maximum additionality rate based on the respondents' answers to the impact of R&D input price change.

Question 22 asks respondents to give a proportion of their R&D expenditure for these three cases:

- R&D Tax Incentive was not considered (r_1)
- R&D Tax Incentive was considered, but did not change the decision to fund R&D (r_2)
- R&D Tax Incentive was considered and materially influenced the decision to fund the R&D (r_3)

It is obvious that the first case should be excluded from additionality calculations as the R&D TI was not considered, and thus there was no inducement for this proportion of R&D. This leads to Method B by adjusting the rate from direct method (AR^A) by the share where the R&D TI was not considered in the R&D decision:

$$AR^B = (r_2 + r_3) \sum_i (s_i \varepsilon_i)$$

It is arguable that the second case also be excluded from the additionality calculations as the R&D TI did not change the decision to fund R&D. In other words, the R&D spending would happen anyway, therefore, there is no extra R&D induced by the programme. This leads to Method C, which includes only the proportion of R&D spending decision which has been materially influenced by R&D TI:

$$AR^C = (r_3) \sum_i (s_i \varepsilon_i)$$

Taking consideration of constraints

The Simple Model calculation may overlook important constraints on R&D activity as well. For example, expanding R&D needs to employ more people with special expertise. In many cases, firms are difficult to find such skilled labour even if they feel the labour price is cheaper, especially when the cheap price is induced by forces out of the market. On the other hand, firms may not engage in more R&D activities even if doing R&D is cheaper, simply because further R&D may not bring about higher profits.

These two types of constraints, resource availability and opportunity and motivation, were explicitly asked in the survey. The calculation of inducement could be modified by incorporating these constraints. Specifically, adjusting factors were included in the formula to reflect the constraints:

$$AR^D = (r_2 + r_3) \sum_i (f_i s_i \varepsilon_i) \text{ and } AR^E = (r_3) \sum_i (f_i s_i \varepsilon_i).$$

Table G.1 Mapping constraints to R&D inputs

Constraint	Rent, building or plant/machinery	Skilled labour	Feedstock	Other general material inputs	Specialised technical or laboratory equipment	Collaboration	Contracted out R&D	Purchase of rights to IP/Licensing cost	Other
Limited technical opportunity	–	–	–	–	–	–	–	–	–
Limited market opportunity	–	–	–	–	–	–	–	–	–
More profitable overseas	–	–	–	–	–	–	–	–	–
Too risky	–	–	–	–	–	–	–	–	–
Hard to keep return from R&D	–	–	–	–	–	–	–	–	–
Lower expected returns	–	–	–	–	–	–	–	–	–
Capital	1	–	1	1	–	1	1	1	–
Skilled labour	–	1	–	–	–	–	–	–	–
Collaborators	–	–	–	–	–	1	1	–	–
Specialised equipment	–	–	–	–	1	–	–	–	–
Company tax rate	–	–	–	–	–	–	–	–	–
Regulations	1	1	1	1	1	–	–	–	–
Labour market controls	–	1	–	–	–	–	–	–	–
Cost of patents and other IP	–	–	–	–	1	1	1	1	–
Inadequate protection of IP	–	–	–	–	–	–	–	–	–
Other	–	–	–	–	–	–	–	–	–

Note: 1 indicates the constraint is relevant for the R&D input category

Source: CIE construction.

The adjusting factors, f_i , are calculated according to the ratings firms put to each constraint:

$$f_i = 1 - \sum_j w_{ij} (r_j/10)^2$$

The value of the adjusting factor lies between 0 and 1. In the calculation of f_j , r_j is transformed score of importance a firm put on constraint j . Specifically, the scores of 1 (not important), 2 (somewhat important), 3 (moderately important), 4 (very

important) and 5 (extremely important) are transformed to rate of 0, 2.5, 5, 7.5 and 10, respectively.

If a firm puts a score of 5 ($r = 10$ after transformation) to one factor, it means that factor is highly constraint and the cost reduction caused by tax incentive does not affect the firm's demand for R&D, in this case the adjusting factor is 0. On the other hand, if a score of one ($r = 0$ transformation) is given to a factor, it means that factor is not constraint, and the value of the adjusting factor is 1 and the changes in cost take full effect in the demand for R&D.

In the calculation of f_j , w_{ij} is a weighting parameter to map individual constraint j to individual R&D input i . The mapping from the constraint given in answers to question 14 to the cost components in question 15 is given in Table G.1. We assume each relevant constraint has equal weighting for the input. For example, capital availability and regulations constraint are two relevant constraints to the R&D input of rent, building or plant/machinery, and the weights are 0.5 for both constraints for this input.

Structural approach

Generally a firm asks two questions when deciding its R&D activities: how will the proposed R&D project contribute to the firm's profitability and how much it will cost to undertake the project? Therefore the firm's R&D decision could be broken into two steps. First, a profit maximisation problem, where R&D activity is an input together with capital, labour and other materials, is solved to determine the demand for R&D. Then a cost minimisation problem is solved to decide the demand for each component of R&D given the level of the R&D determined in the first problem.

Formally, assuming that firm's production function is

$$Q = f(R, O^Q)$$

Where Q , R and O^Q , are, respectively, output level, R&D activity and other inputs (including capital, labour and intermediates). The profit maximisation problem is

$$\max P f(R, O^Q) - P_R(1 + T_R)(1 + \tau)R - P_O^Q K^Q$$

where P , P_R and P_O^Q , are, respectively, output price, price (or unit cost) of R&D activity, and price of other materials. T_R is the price-equivalent of constraints on the quantity of R&D demanded. Some factors imposing such constraints are listed in Question 14—for example, 'inadequacy of intellectual property protection', and the impact of each factor rated from 0 to 10 (after transformation). The non-binary nature of the rating system and the uncertainty as to the precise nature of the constraints could be reflected by defining T_R as:

$$T_R = \left(\frac{R}{R_0}\right)^\rho$$

As $\rho \rightarrow \infty$ the firm faces an upper bound of R_0 on the quantity of R&D demanded. As $R_0 \rightarrow \infty$ with $\rho > 0$ there are no quantitative constraints on R&D. Values for ρ and R_0 could be imputed based on ratings in Question 14 (mainly from sections 'Opportunity

and motivation' and 'Government constraints', with high ratings implying high ρ and low R_θ) and the sensitivity of results with respect to the method of imputation tested. τ is a price-equivalent related to firm policy with respect to R&D (for example, hurdle rates). The first order conditions are

$$(P + P'f)f_R = (1 + \tau)[(P_R + P'_R R)(1 + T_R) + P_R \rho T_R]$$

And

$$(P + P'f)f_O = P_O^Q$$

Where f_i is the partial derivative of output with respect to individual input i . The demand for R&D is determined by solving the first order conditions:

$$R^D = R(P, P_R, P_O, O^Q)$$

Two features are noteworthy in the first order conditions. First, there is an allowance for the firm's market power via the inclusion of P' in the first order conditions. The dependence of price on the total quantity of goods produced could be imputed for those firms that answer question 30. Second, the price of R&D P_R may depend on the quantity of R&D. This will occur even with constant returns to scale technology in producing R&D if quantitative constraints on inputs to the R&D activity are represented in the same manner as that embodied in T_R .

Once the R&D level is determined, a cost minimisation problem is set up to determine the demand for each component of R&D:

$$\begin{aligned} \min \{ & r(1 + T_K)K + w(1 + T_L)L + P_M(1 + T_M)M + P_T(1 + T_T)T + P_C(1 + T_C)C \\ & + P_O(1 + T_O)O \} \end{aligned}$$

$$s. t. R^D = g(K, L, M, T, C, O)$$

$\{T_\theta: \theta \in \{K, L, M, T, C, O\}\}$ are the price-equivalents of constraints on inputs to the R&D activity. Some factors imposing such constraints are listed in Q14, and the impact of each factor rated from 1 to 10. Following the same treatment as for T_R , these price-equivalents are defined as:

$$T_\theta = \left(\frac{\theta}{\theta_0}\right)^{\rho_\theta}, \quad \forall \theta \in \{K, L, M, T, C, O\}$$

Values for ρ_θ and θ_0 could be imputed based on ratings in the resource availability section of Q14 (mainly from the section 'Resource availability', with high ratings implying high ρ_θ and low θ_0) and the quantitative responses in Question 16. The first order conditions are:

$$\lambda g_K = r(1 + T_K(1 + \rho_K))$$

$$\lambda g_L = r(1 + T_L(1 + \rho_L))$$

$$\lambda g_M = r(1 + T_M(1 + \rho_M))$$

$$\lambda g_T = r(1 + T_T(1 + \rho_T))$$

$$\lambda g_C = r(1 + T_C(1 + \rho_C))$$

$$\lambda g_O = r(1 + T_O(1 + \rho_O))$$

Where g_i is the partial derivative of the quantity of R&D undertaken with respect to the input i into the R&D activity and λ is the Lagrange multiplier associated with the R&D production function g . Note that $\lambda = P_R$ in the profit-maximisation production decision. If the R&D production function g exhibits constant returns to scale then Euler's theorem states that:

$$g = K g_K + L g_L + M g_M + T g_T + C g_C + O g_O$$

so, consequently,

$$\lambda = \frac{\left(\frac{r(1+T_K(1+\rho_K))K + w(1+T_L(1+\rho_L))L + P_M(1+T_M(1+\rho_M))M}{+P_T(1+T_T(1+\rho_T))T + P_C(1+T_C(1+\rho_C))C + P_O(1+T_O(1+\rho_O))O} \right)}{R^D}$$

As noted previously, $P'_R = \delta\lambda/\delta R^D$ is also required for the firm's profit-maximizing production decision. It is obtained by partially differentiating the first order conditions associated with the firm's R&D decision to yield:

$$\begin{aligned} \lambda \sum_{\Theta \in \{K,L,M,T,C,O\}} g_{K\Theta}(\delta\Theta/\delta R^D) + g_K(\delta\lambda/\delta R^D) &= r(T_K/K)(1 + \rho_K) \rho_K(\delta K/\delta R^D) \\ \lambda \sum_{\Theta \in \{K,L,M,T,C,O\}} g_{L\Theta}(\delta\Theta/\delta R^D) + g_L(\delta\lambda/\delta R^D) &= w(T_L/L)(1 + \rho_L) \rho_L(\delta L/\delta R^D) \\ \lambda \sum_{\Theta \in \{K,L,M,T,C,O\}} g_{M\Theta}(\delta\Theta/\delta R^D) + g_M(\delta\lambda/\delta R^D) &= P_M(T_M/M)(1 + \rho_M) \rho_M(\delta M/\delta R^D) \\ \lambda \sum_{\Theta \in \{K,L,M,T,C,O\}} g_{T\Theta}(\delta\Theta/\delta R^D) + g_T(\delta\lambda/\delta R^D) &= P_T(T_T/T)(1 + \rho_T) \rho_T(\delta T/\delta R^D) \\ \lambda \sum_{\Theta \in \{K,L,M,T,C,O\}} g_{C\Theta}(\delta\Theta/\delta R^D) + g_C(\delta\lambda/\delta R^D) &= P_C(T_C/C)(1 + \rho_C) \rho_C(\delta C/\delta R^D) \\ \lambda \sum_{\Theta \in \{K,L,M,T,C,O\}} g_{O\Theta}(\delta\Theta/\delta R^D) + g_O(\delta\lambda/\delta R^D) &= P_O(T_O/O)(1 + \rho_O) \rho_O(\delta O/\delta R^D) \end{aligned}$$

then multiplying each of these equations by the associated quantity, summing and invoking Euler's theorem (assuming again that g exhibits constant returns to scale) to obtain:

$$\delta\lambda/\delta R^D = \frac{\left[\begin{aligned} &rT_K(1 + \rho_K)\rho_K(\delta K/\delta R^D) + wT_L(1 + \rho_L)\rho_L(\delta L/\delta R^D) \\ &+ P_M T_M(1 + \rho_M)\rho_M(\delta M/\delta R^D) + P_T T_T(1 + \rho_T)\rho_T(\delta T/\delta R^D) \\ &+ P_C T_C(1 + \rho_C)\rho_C(\delta C/\delta R^D) + P_O T_O(1 + \rho_O)\rho_O(\delta O/\delta R^D) \end{aligned} \right]}{R^D}$$

The previous seven equations are all required to define $\delta\lambda/\delta R^D$.

One advantage of the structural approach over the direct and simple approaches is that it accommodates large changes in prices and quantities. The direct approach is only accurate for small changes. Prior expectations about the likely magnitude of changes may give some indication of whether the degree of accuracy of the direct approach is likely to be adequate. However, a definitive result regarding accuracy can only be obtained ex-post using the survey data. The structural approach also imputes cross-

price effects in a way that is consistent with profit-maximising and cost-minimising behaviour.

$T_{\theta} \rho_{\theta}$

Choosing the price-equivalents of quantitative restrictions

Each price-equivalent T_{θ} of quantitative restrictions is a function of two parameters— ρ_{θ} and θ_{θ} . ρ_{θ} is the elasticity of the price-equivalent with respect to the quantity, intuitively, the rate at which increases in the quantity ‘tighten’ the constraint. θ_{θ} is a location parameter for the constraint, intuitively, it determines the level near which the constraint starts to ‘bite’. For example, as $\rho_{\theta} \rightarrow \infty$ it is the upper bound on the quantity.

Values for ρ_{θ} and θ_{θ} should somehow be sensibly related to the ratings in question 14—increasing and decreasing functions of the ratings. However, the most natural mapping is from a rating to an initial value of the price-equivalent T_{θ} . As the nature of constraints is not clear from just the rating, so, a fortiori, it is unclear how the value assigned to the price-equivalent should be partitioned between ρ_{θ} and θ_{θ} . As a first approach, for a given value of ρ_{θ} (to be determined as described at the end of this section), θ_{θ} could be chosen so as to ensure an appropriate ratings-based initial value $T_{\theta} = T_{\theta 0}$ of the price-equivalent. One possible flexible mapping from ratings to initial price-equivalents is:

$$T_{\theta 0} = (\Omega_{\theta}/10)^a \hat{T}_{\theta}$$

where a is a positive number, $\hat{T}_{\theta}$ is the maximum initial value of a price-equivalent that can be assigned to T_{θ} and Ω_{θ} is a type of average of the ratings for all responses in Q14 relevant to item θ .

$\hat{T}_{\theta}$ measures the maximum price-equivalent of constraints that may be faced by the firm. A basic idea is that highly novel technology R&D requires specialised technical equipment and skills, therefore it is more likely for the firm to face constraints from the supply side. Therefore, the determination of $\hat{T}_{\theta}$ can be related to answers to Question 25: a high share of novel technology in R&D assigns a high value of $\hat{T}_{\theta}$. A starting point will be to use that share directly.

A formal treatment of Ω_{θ} is:

$$\Omega_{\theta} = [\sum_r b_r S_r^c]^{1/c} \quad \sum_r b_r = 1$$

$$\Omega_{\theta} = \left[\sum_r b_r S_r^c \right]^{1/c} \quad \sum_r b_r = 1$$

Where b_r are weights which map the relevant rating from Question 14 to the price-equivalent constraint. Table G.1 provides the mapping.

The value $c = 1$ provides a weighted-arithmetic average of the ratings S_r , $c \rightarrow 0$ a geometric average and $c \rightarrow \infty$ the maximum of the ratings. We could start with $c = 1$, and consequently experiment with $c = 2, 5, 10$.

Once $\hat{T}_\theta$ is determined, θ/θ_0 or θ_0 (θ being derivable from survey responses) can be derived through $\hat{T}_\theta = (\theta/\theta_0)^{\rho_\theta}$ for any particular value of ρ_θ . The value of ρ_θ to be used could then be determined from the quantitative responses in Question 16.

Choosing production functions for the R&D and final product activities

A desirable requirement for the production functions f and g is that they should be flexible enough to allow variation in the own-price effect associated with each input. This will allow sensitivity testing of imputed supply-side parameters (especially ρ_θ) with respect to demand-side flexibilities in input use. The CRESH (Constant Ratio Elasticity of Substitution Homothetic) functional form has the required flexibility and is an analytically simple form to incorporate in the first order conditions. For each input, the CRESH functional form has an associated parameter that governs the own-price response of the input. The Allen elasticity of substitution between two inputs is proportional to the product of the associated parameters. Consequently, the ratio of any two elasticities of substitution is constant across the entire range of relative input prices. As cross-price effects must be imputed in this study, some such global constancy of these effects is desirable.

A CRESH combination Q of inputs Q_i is defined by the equation:

$$\sum_i \alpha_i (Q_i/Q)^{\beta_i} = 1$$

The parameters β_i influence the magnitudes of the associated own-price effects, such as those contained in Question 16, for example. If all β_i are equal then the CRESH form reduces to the CES production function.

The first order conditions for the firms production and R&D decisions contain the partial derivatives of the production functions f and g with respect to inputs, that is, $\delta Q/\delta Q_j$ in the current notation. If the CRESH definition is partially differentiated with respect to Q_j then the expression obtained is:

$$\sum_i \alpha_i (\delta_{ij} \beta_i (Q_i^{\beta_i-1}/Q^{\beta_i}) - \beta_i (Q_i^{\beta_i}/Q^{\beta_i+1}) \cdot \delta Q/\delta Q_j) = 0$$

so

$$\begin{aligned} \delta Q/\delta Q_j &= \frac{\alpha_j \beta_j (Q_j^{\beta_j-1}/Q^{\beta_j})}{\sum_i \alpha_i \beta_i (Q_i^{\beta_i}/Q^{\beta_i+1})} \\ &= \frac{\alpha_j \beta_j (Q_j/Q)^{\beta_j-1}}{\sum_i \alpha_i \beta_i (Q_i/Q)^{\beta_i}} \end{aligned}$$

The definition of $\delta \lambda/\delta R^D$ (derived from the firm's R&D decision and used in the firm's profit-maximization production decision) requires the second-order partial derivatives of g with respect to inputs. These can be derived from the CRESH functional form by taking logarithms on both sides of the previous relationship and differentiating it with respect to Q_k to yield:

$$\delta^2 Q / \delta Q_j \delta Q_k = \left[\frac{(\beta_j - 1) \left(\delta_{jk} / Q_j - (1/Q) (\delta Q / \delta Q_k) \right) + \sum_i \alpha_i \beta_i^2 (Q_i / Q)^{\beta_i - 1} (\delta_{ik} / Q - (Q_i / Q^2) (\delta Q / \delta Q_k))}{\sum_i \alpha_i \beta_i (Q_i / Q)^{\beta_i}} \right] (\delta Q / \delta Q_j)$$

Consequently, a CRESH functional form for f and g can be easily incorporated in the first order conditions previously derived.

The CRESH parameters can be determined so that the demand functions are satisfied at the levels of inputs and outputs provided in survey responses, given values for the parameters. The choice of parameters for f are governed by the responses to the Question 30. The parameters in g are the subject of sensitivity testing to determine their influence on supply-side parameters imputed from Questions 14 and 16.

H Cut-off points to classify firms

This appendix presents additional details of the results of finding an appropriate cut-off point to classify a firm as large or small as discussed in Chapter 8. The purpose of the analysis is to identify a point where the difference in additionality rates between large firms and SMEs is maximised.

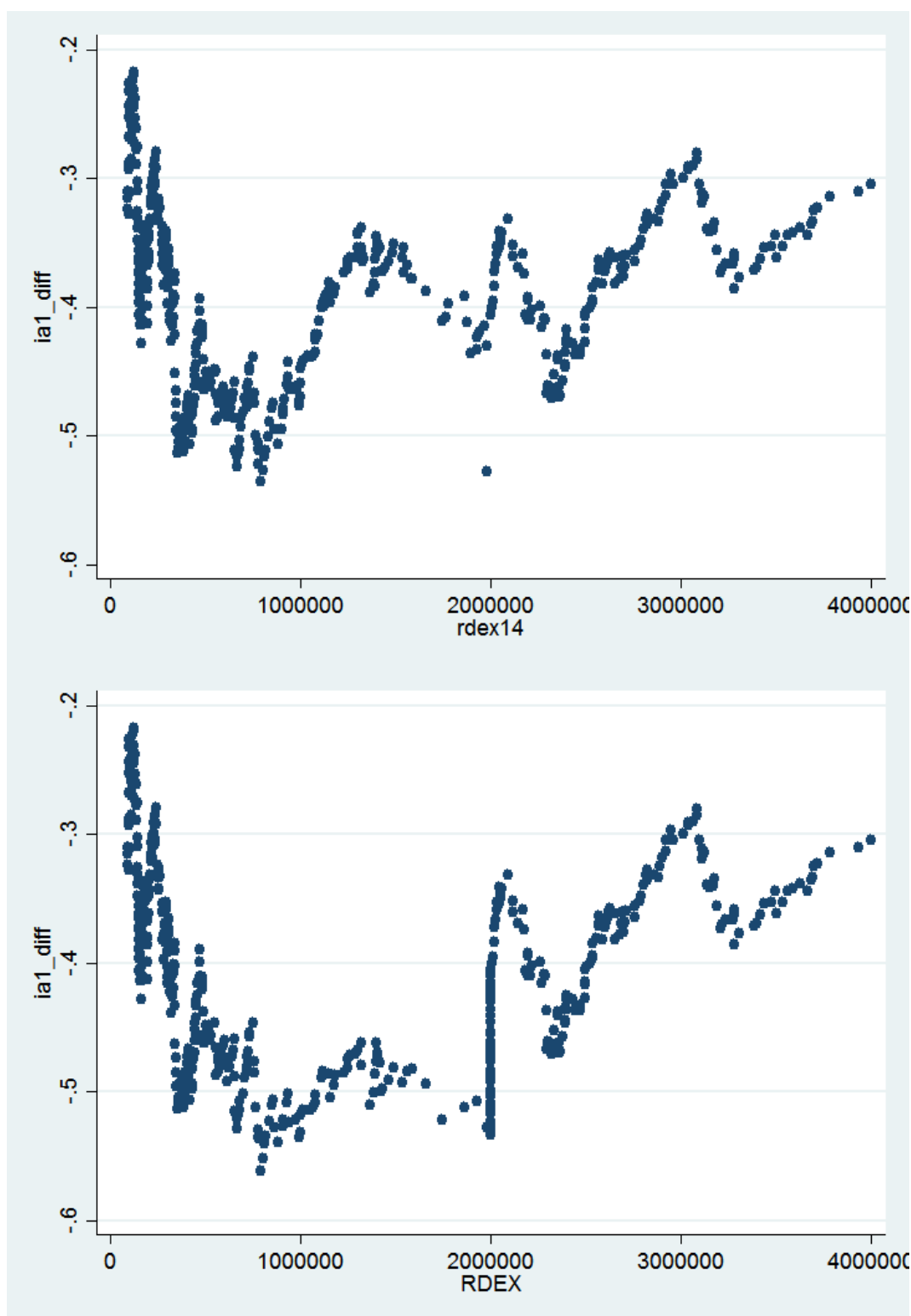
Charts H.1 through to H.7 show the results of classifying firms according to their R&D expenditures, and charts H.8 to H.14 the results according to their turnover. Each set of charts corresponds to each of the seven methods used to estimate the additionality rate as described in Chapter 8.

In each diagram, the horizontal axis shows the cut-off points of R&D expenditure or turnover, and the vertical axis shows the difference in the weighted average additionality rate between large firms and SMEs (defined according to the relevant cut-off point; negative values imply the average large firm additionality rate is less than SME rate).

The main observations from these charts are:

- SMEs have a consistently higher additionality rate than large firms over a wide range of cut-off points, for example, R&D expenditure as high as of \$4 million, or turnover of \$40 million
- there is not enough information to pick a definite cut-off point to classify firms, and
- it is most likely that the optimal cut-off point would be below R&D expenditure of \$2 million or below turnover of \$20 million.

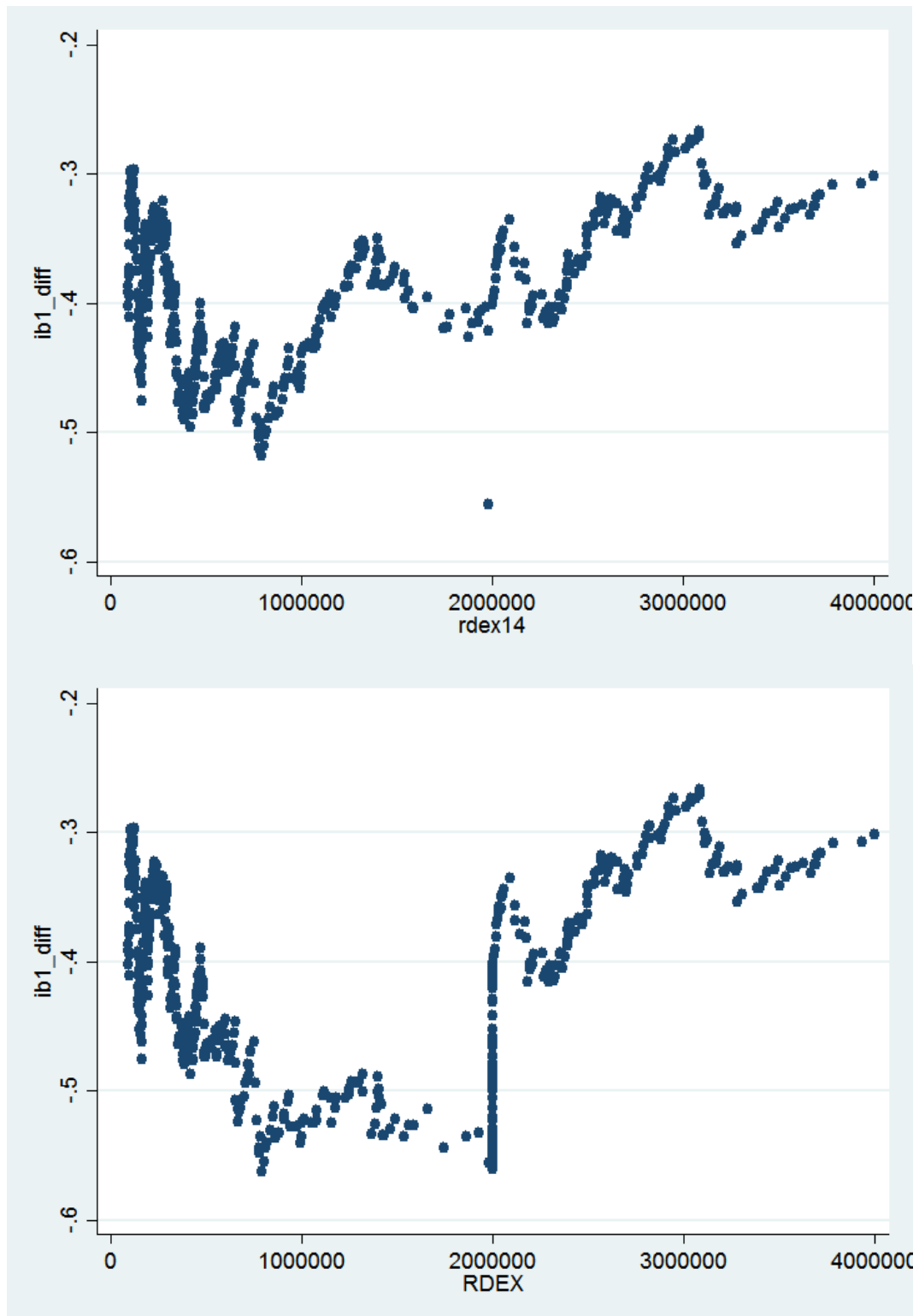
Chart H.1 Difference in additionality rates between large firms and SMEs along R&D expenditure cut-off points: Method A



Note: split firms to large and SMEs according to their R&D expenditure in 2013–14 (top panel) and adjusted by historical R&D expenditure (bottom panel)

Data source: CIE calculation.

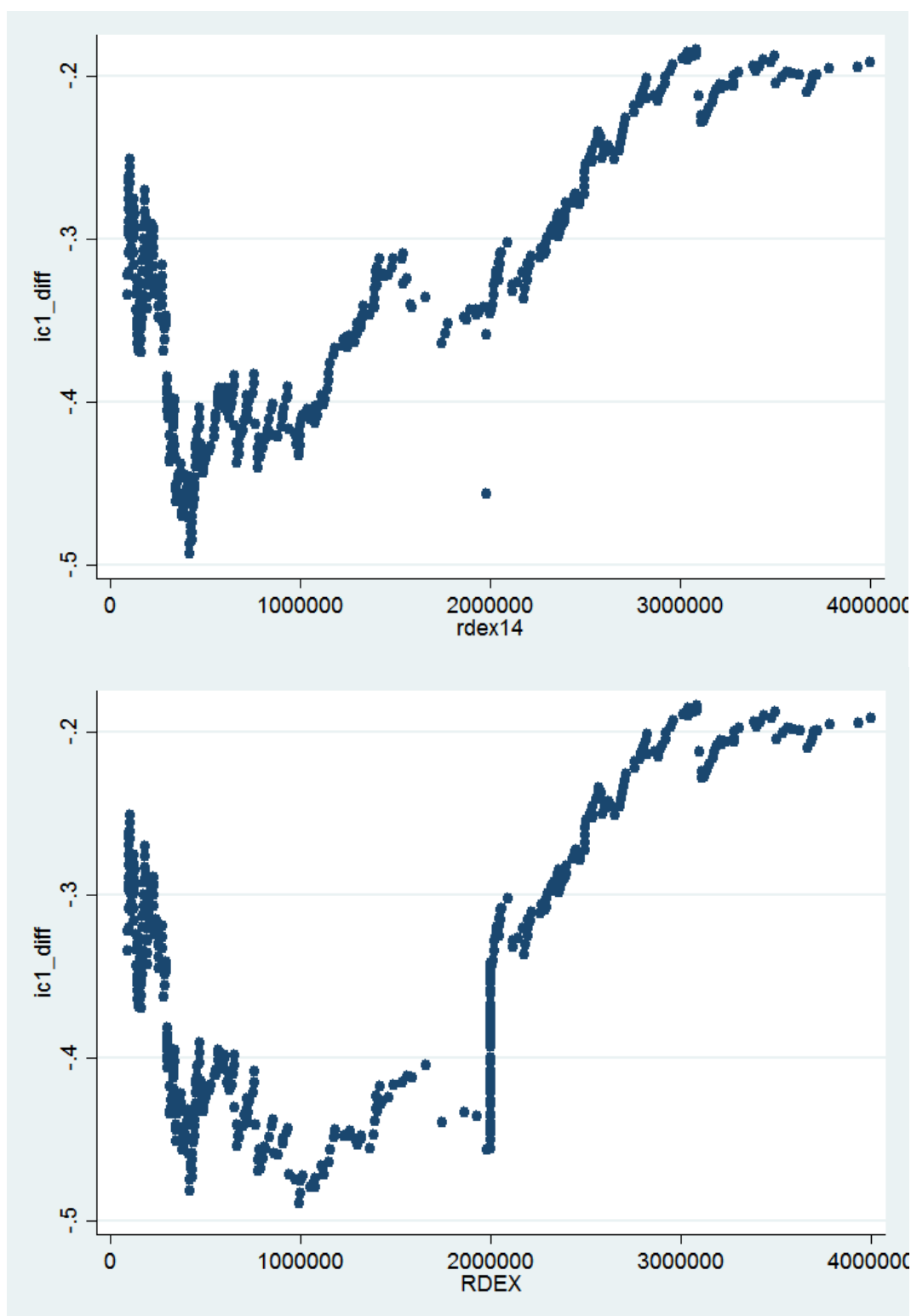
Chart H.2 Difference in additionality rates between large firms and SMEs along R&D expenditure cut-off points: Method B



Note: split firms to large and SMEs according to their R&D expenditure in 2013–14 (top panel) and adjusted by historical R&D expenditure (bottom panel)

Data source: CIE calculation.

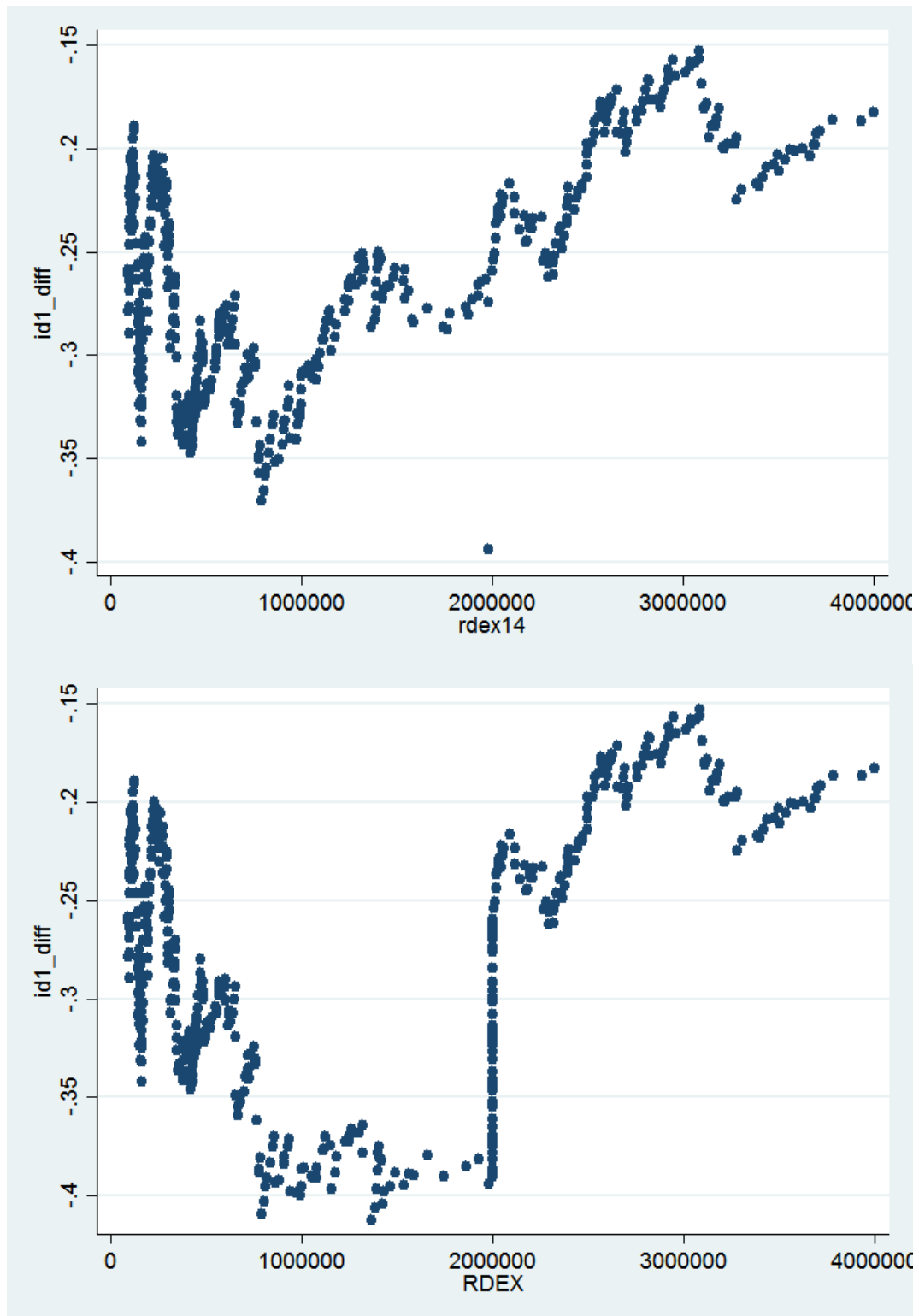
Chart H.3 Difference in additionality rates between large firms and SMEs along R&D expenditure cut-off points: Method C



Note: split firms to large and SMEs according to their R&D expenditure in 2013–14 (top panel) and adjusted by historical R&D expenditure (bottom panel)

Data source: CIE calculation.

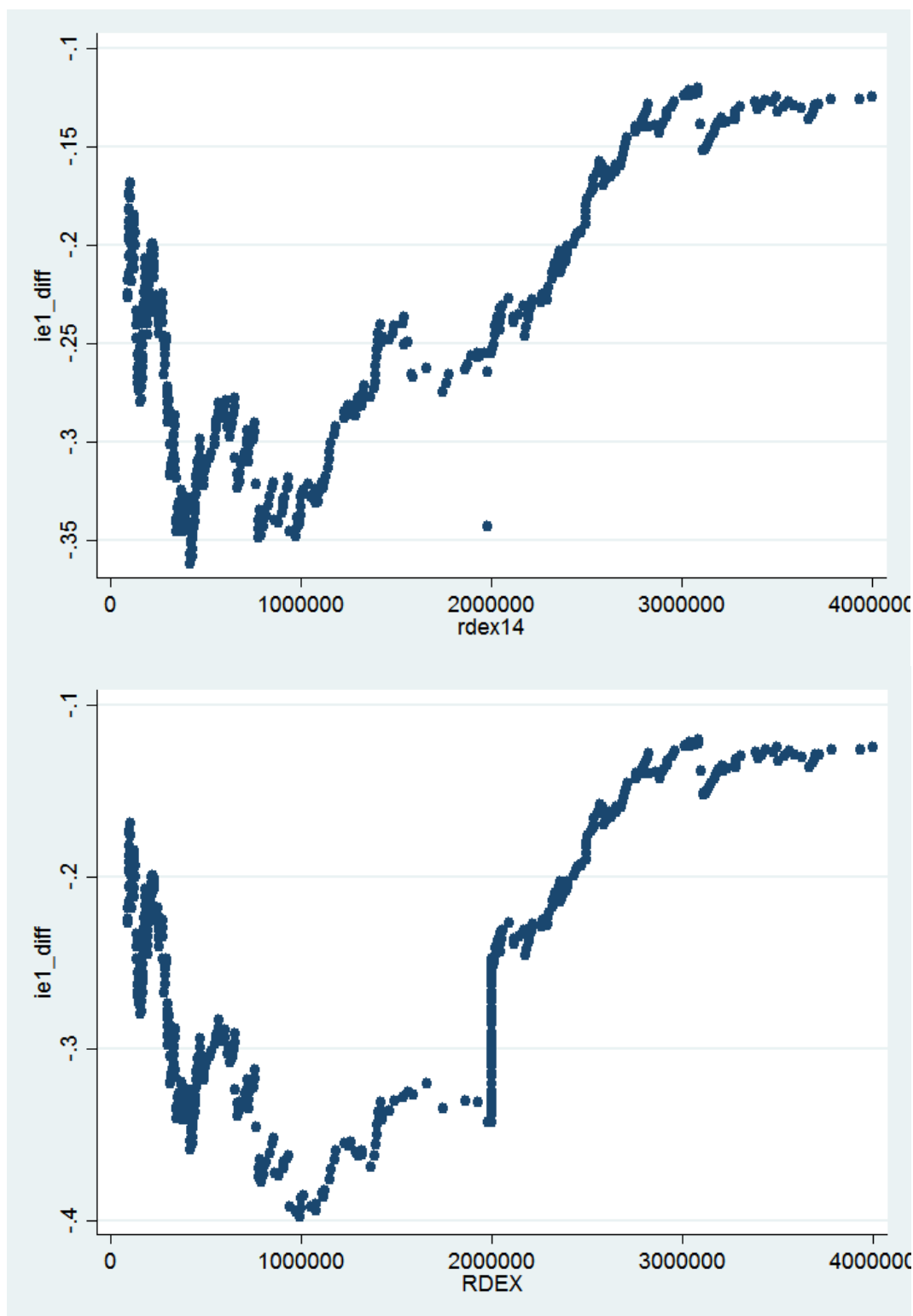
Chart H.4 Difference in additionality rates between large firms and SMEs along R&D expenditure cut-off points: Method D



Note: split firms to large and SMEs according to their R&D expenditure in 2013–14 (top panel) and adjusted by historical R&D expenditure (bottom panel)

Data source: CIE calculation.

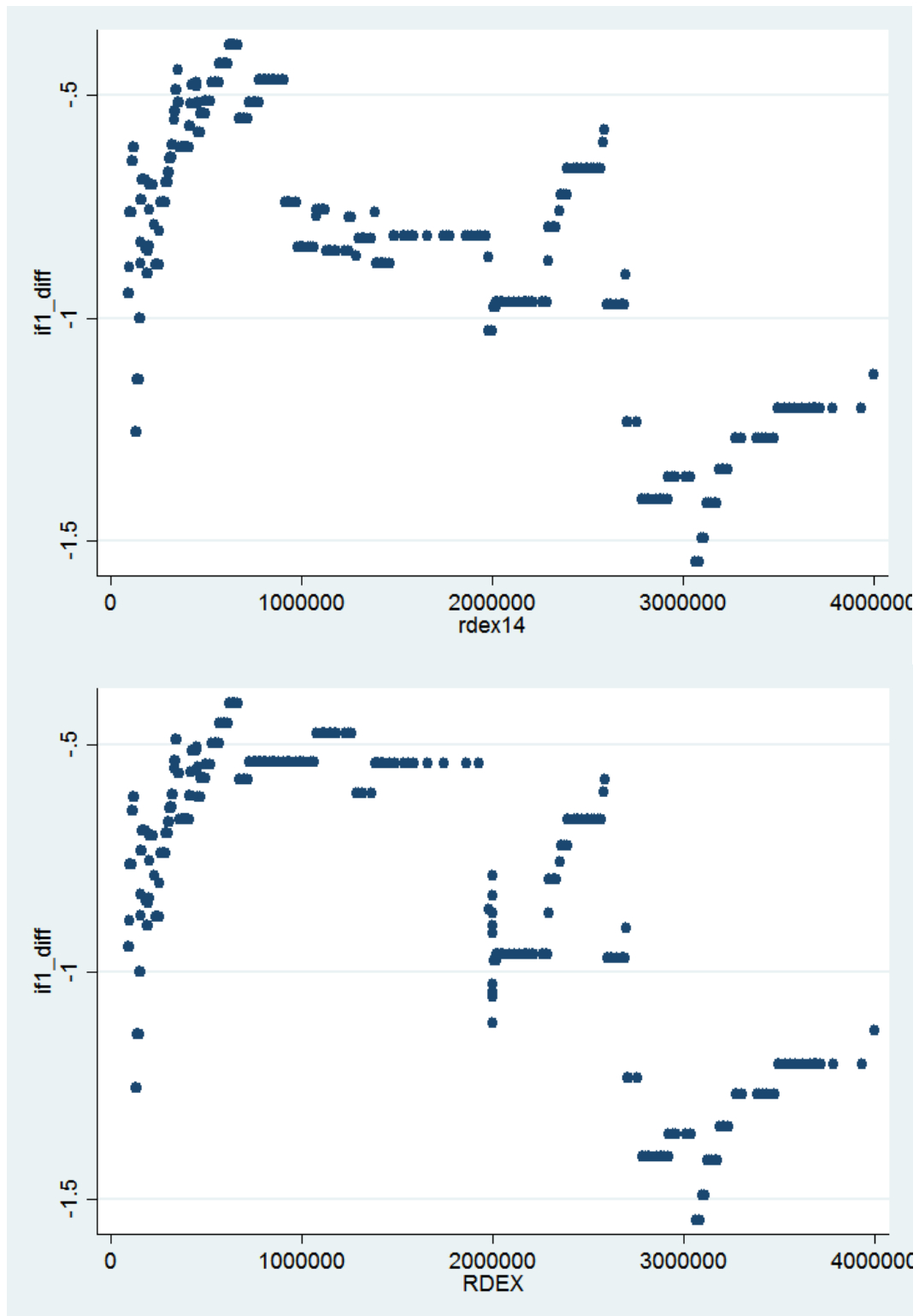
Chart H.5 Difference in additionality rates between large firms and SMEs along R&D expenditure cut-off points: Method E



Note: split firms to large and SMEs according to their R&D expenditure in 2013–14 (top panel) and adjusted by historical R&D expenditure (bottom panel)

Data source: CIE calculation.

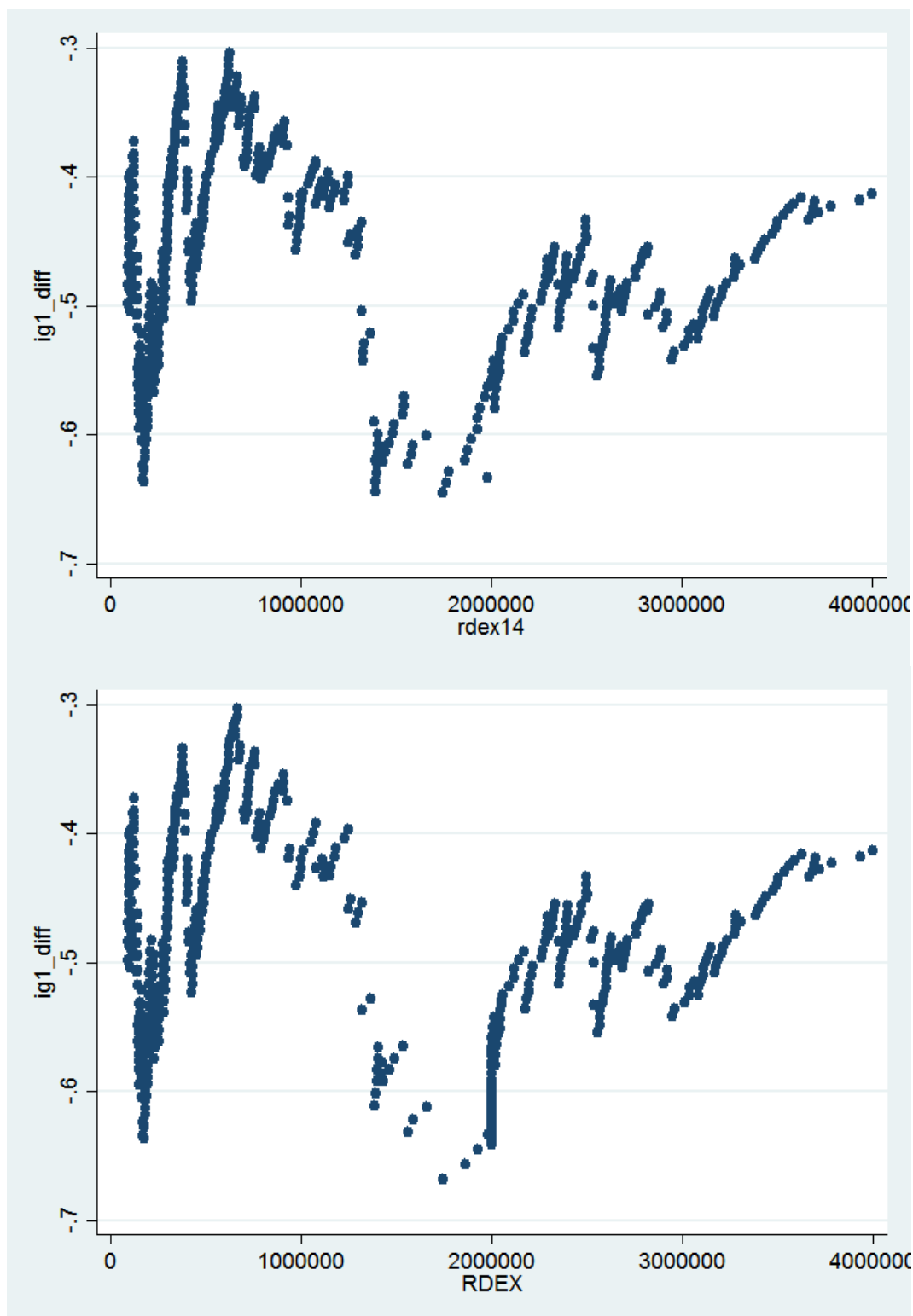
Chart H.6 Difference in additionality rates between large firms and SMEs along R&D expenditure cut-off points: Method F



Note: split firms to large and SMEs according to their R&D expenditure in 2013–14 (top panel) and adjusted by historical R&D expenditure (bottom panel)

Data source: CIE calculation.

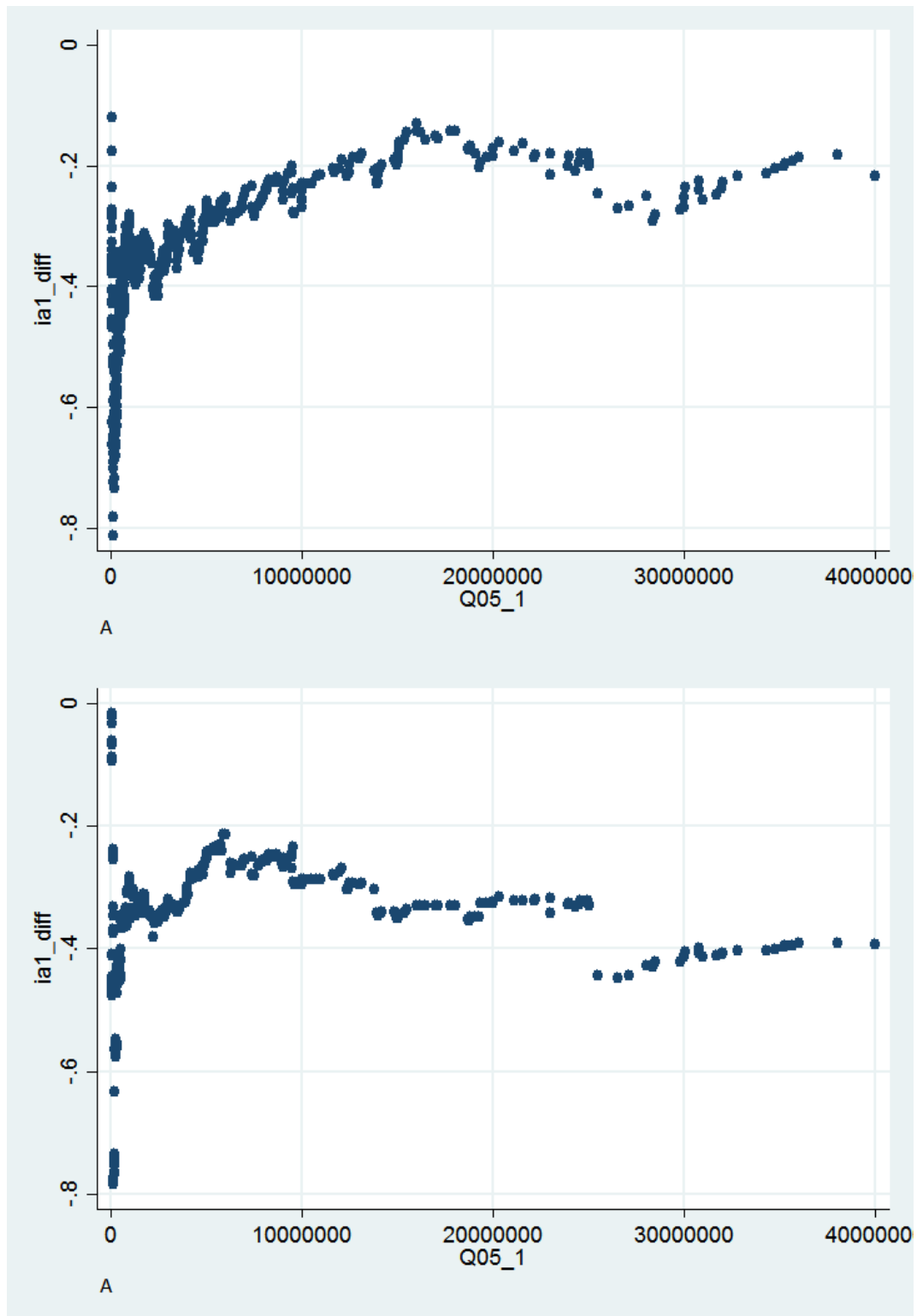
Chart H.7 Difference in additionality rates between large firms and SMEs along R&D expenditure cut-off points: Method G



Note: split firms to large and SMEs according to their R&D expenditure in 2013–14 (top panel) and adjusted by historical R&D expenditure (bottom panel)

Data source: CIE calculation.

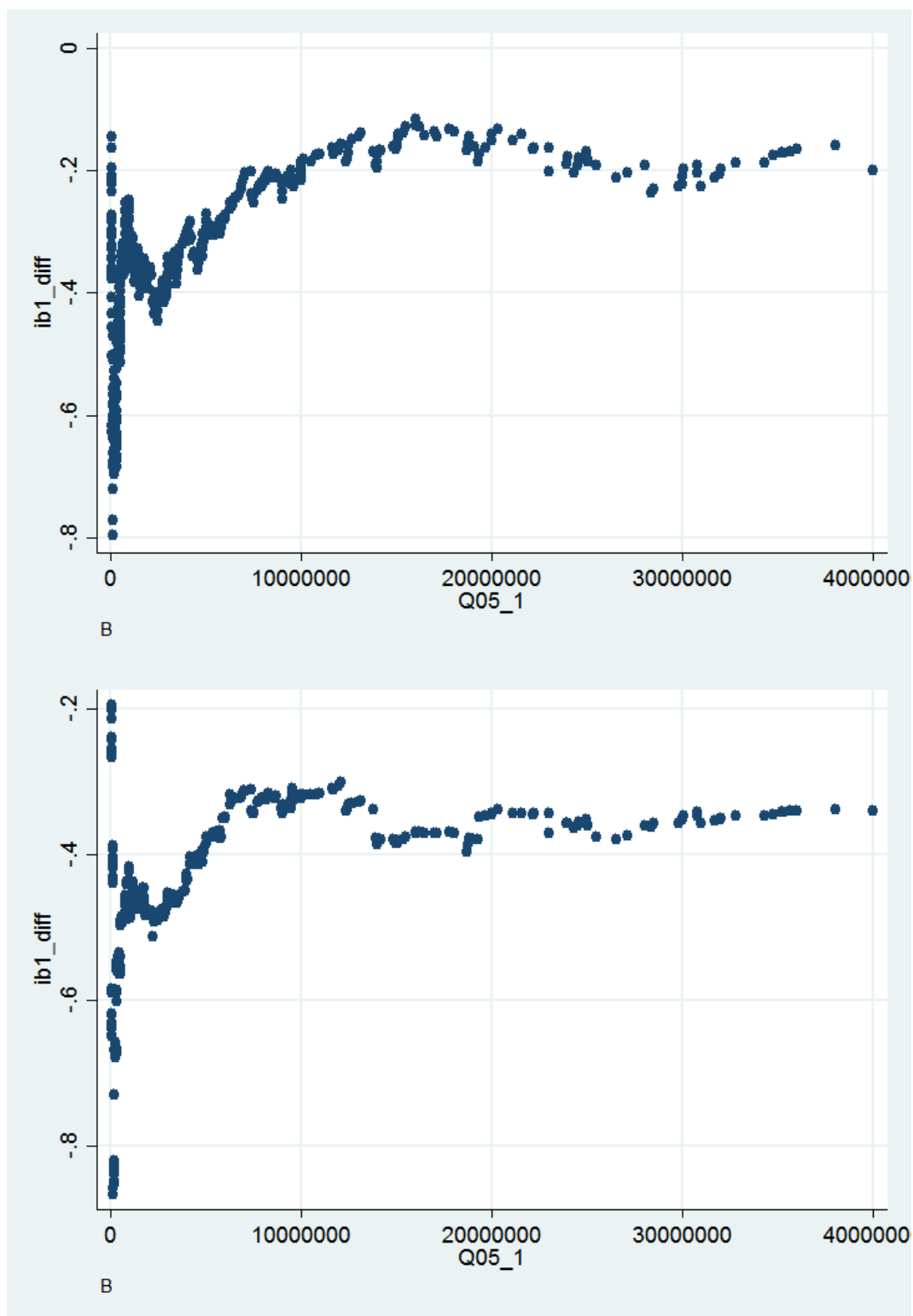
Chart H.8 Difference in additionality rates between large firms and SMEs along the turnover cut-off point: Method A



Note: top panel weighted by turnover, bottom panel weighted by R&D expenditure in 2013–14

Data source: CIE calculation.

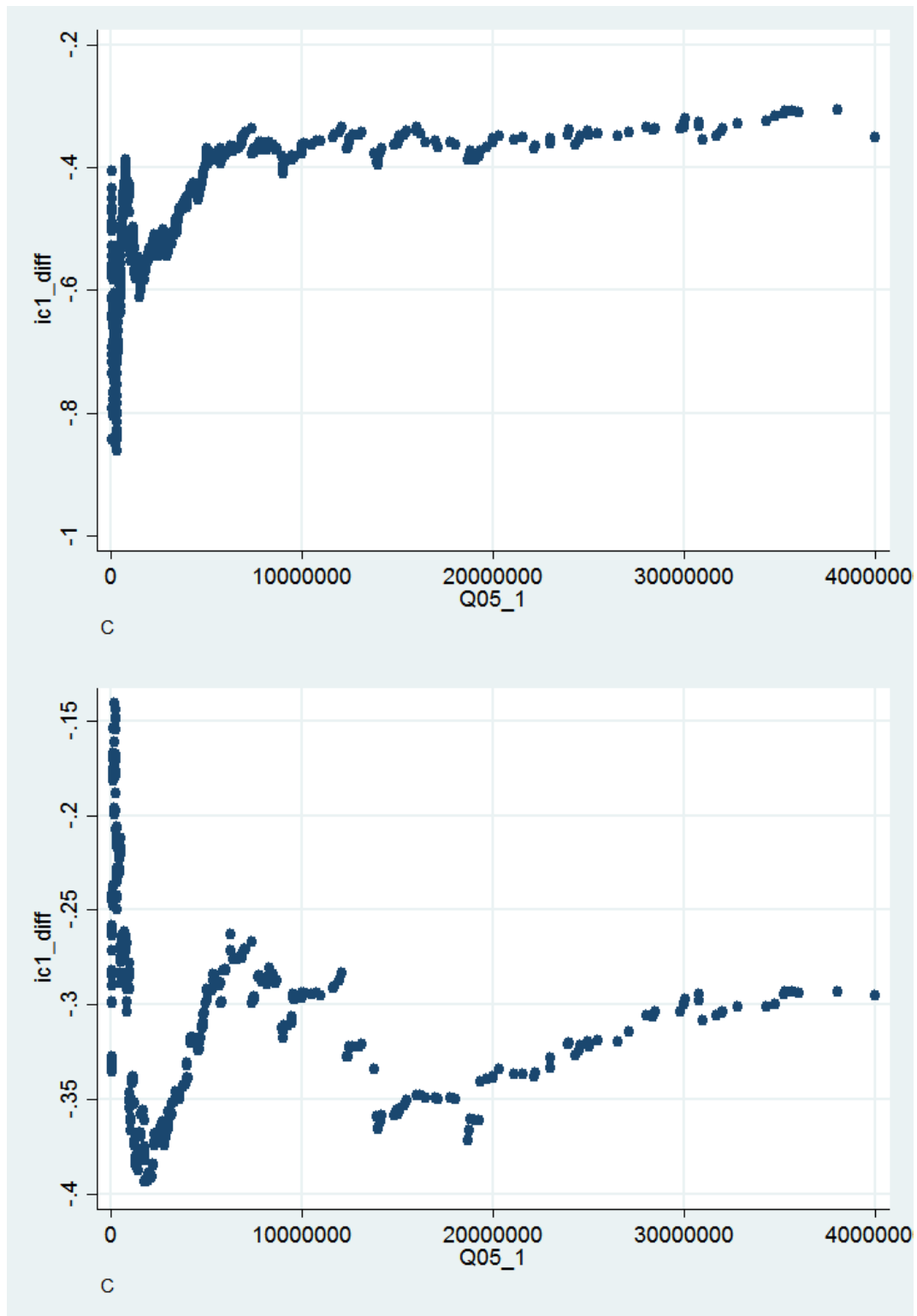
Chart H.9 Difference in additionality rates between large firms and SMEs along the turnover cut-off point: Method B



Note: top panel weighted by turnover, bottom panel weighted by R&D expenditure in 2013-14

Data source: CIE calculation.

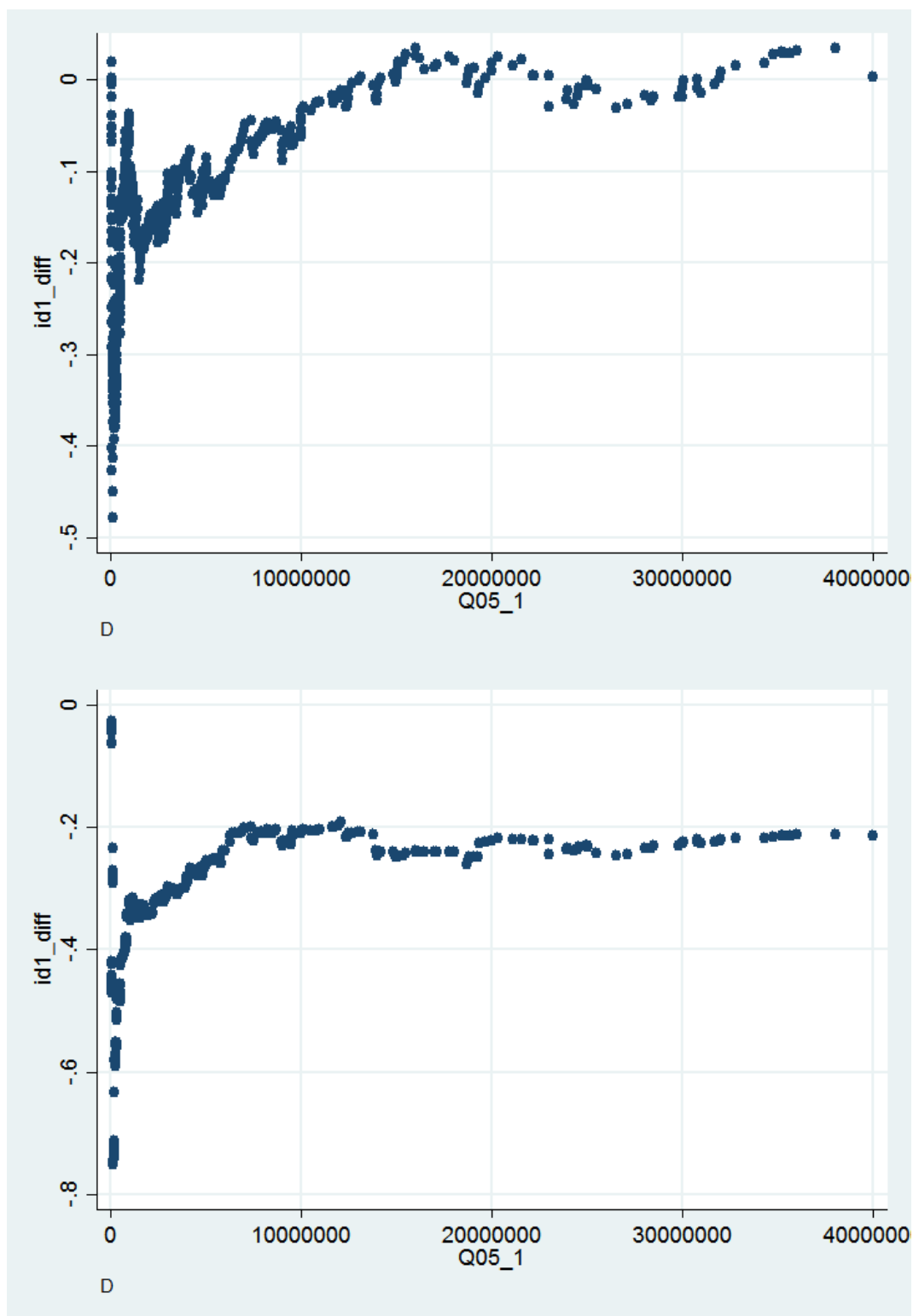
Chart H.10 Difference in additionality rates between large firms and SMEs along the turnover cut-off point: Method C



Note: top panel weighted by turnover, bottom panel weighted by R&D expenditure in 2013-14

Data source: CIE calculation.

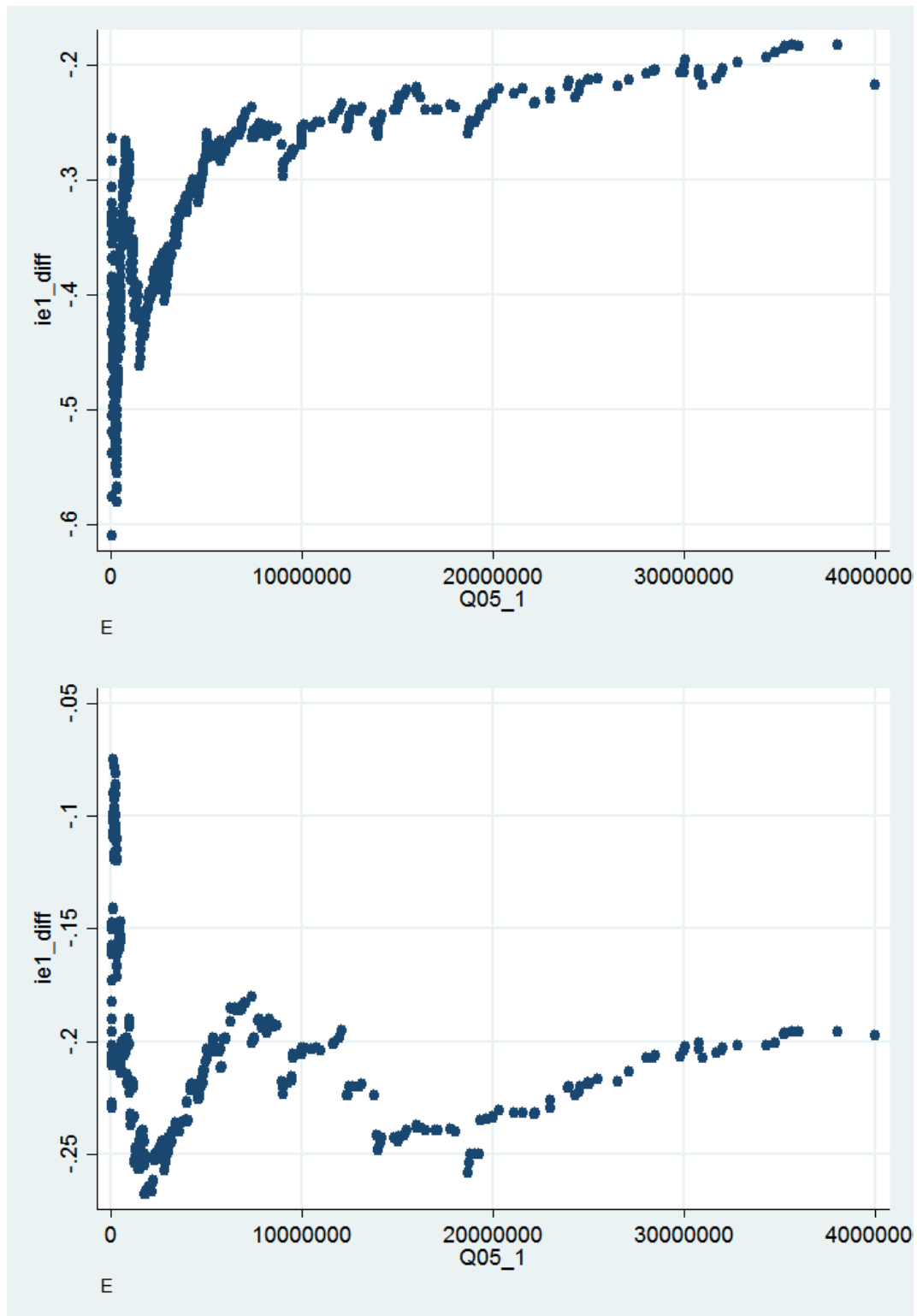
Chart H.11 Difference in additionality rates between large firms and SMEs along the turnover cut-off point: Method D



Note: top panel weighted by turnover, bottom panel weighted by R&D expenditure in 2013–14

Data source: CIE calculation.

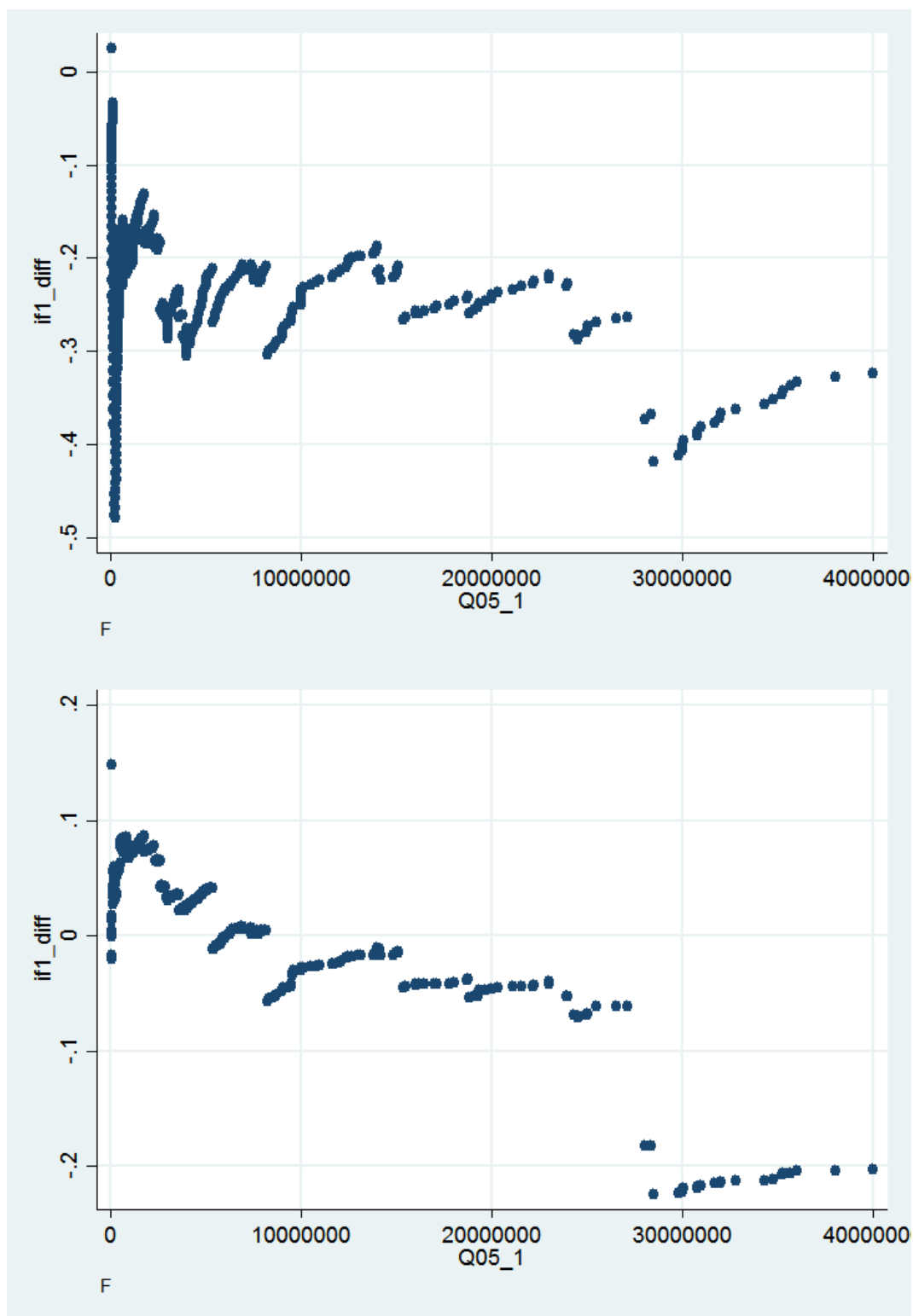
Chart H.12 Difference in additionality rates between large firms and SMEs along the turnover cut-off point: Method E



Note: top panel weighted by turnover, bottom panel weighted by R&D expenditure in 2013-14

Data source: CIE calculation.

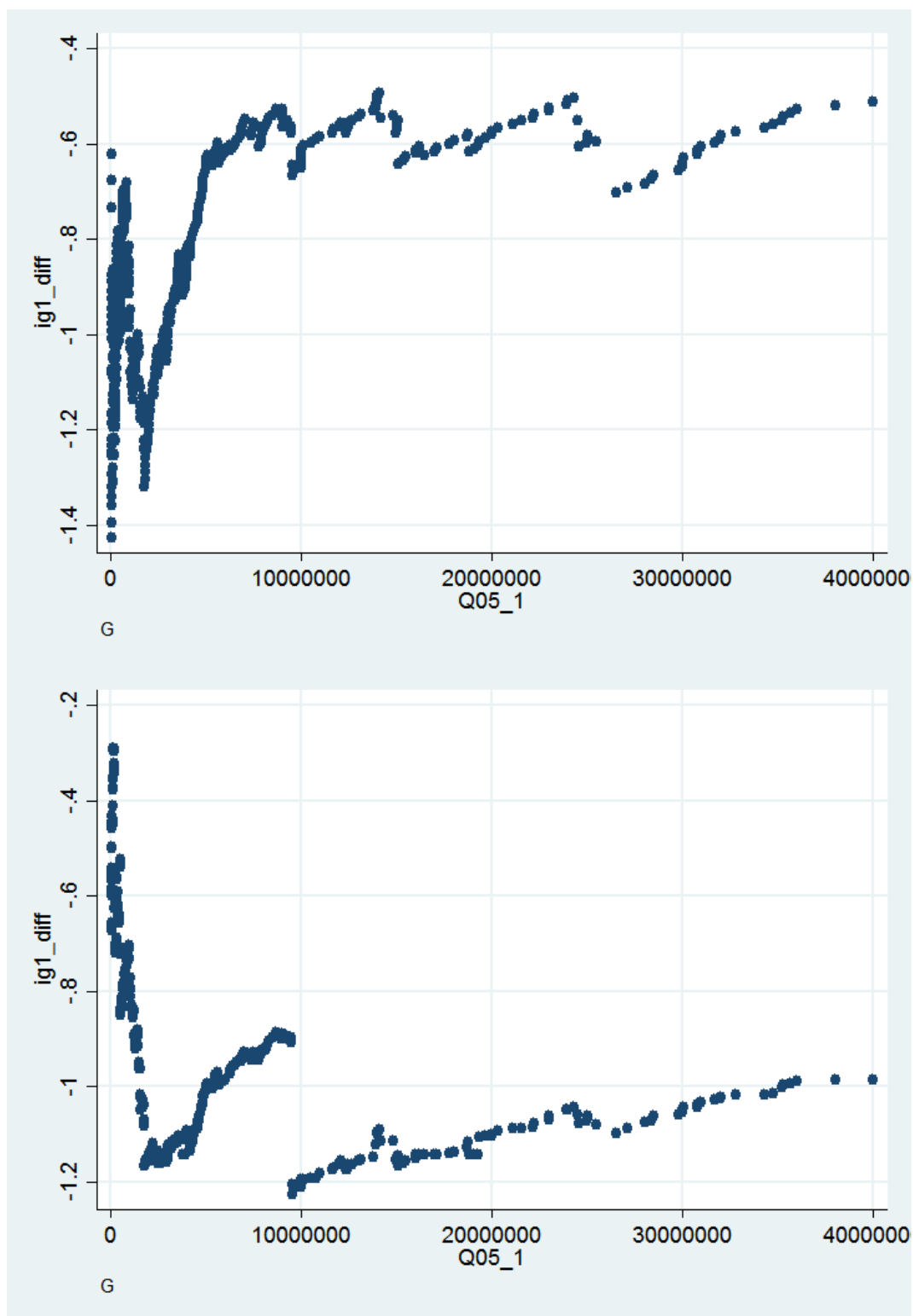
Chart H.13 Difference in additionality rates between large firms and SMEs along the turnover cut-off point: Method F



Note: top panel weighted by turnover, bottom panel weighted by R&D expenditure in 2013-14

Data source: CIE calculation.

Chart H.14 Difference in additionality rates between large firms and SMEs along the turnover cut-off point: Method G



Note: top panel weighted by turnover, bottom panel weighted by R&D expenditure in 2013-14

Data source: CIE calculation.

I CIE-REGIONS model

CIE-REGIONS model is a general equilibrium model of the Australian economy. It was developed by the CIE based on the publicly available MMRF-NRA model developed by the Centre of Policy Studies for the PC (2006).

Some of the key features of this model are that it:

- uses the latest input-output table
- provides a detailed account of industry activity, investment, imports, exports, changes in prices, employment, household spending and savings and many other factors;
 - identifies 58 industries and commodities (Table I.1)
- accounts for Australia's six states and two territories as distinct regions including specific details about the budgetary revenues and expenditures of each of the eight state and territory governments and the Australian Government (the government finances in CIE-REGIONS align as closely as practicable to the ABS government finance data)
 - includes a detailed treatment of the fiscal effects of the Goods and Services Tax (GST)
 - specifically accounts for major taxes including land taxes, payroll taxes, stamp duties and others at the state level, as well as income taxes, tariffs, excise, the GST and other taxes at the federal level (listed in this appendix)
 - traces out the impact of transfers between governments
- accounts for differing economic fundamentals in the states (for instance, the mining boom in WA and Queensland)
- can produce results on employment and value added at a regional level
- can be run in a static or dynamic mode. The dynamic version allows analysis to trace impacts over time as the economy adjusts, being particularly useful over the medium to longer terms.

Table I.1 CIE-REGIONS industries/commodities

Industry code	Industry/commodity description
1	Livestock
2	Crops
3	Forestry
4	Fishing
5	Coal

Industry code	Industry/commodity description
6	Oil
7	Gas
8	Iron ore
9	Other metal ores
10	Other mining
11	Food, beverage and tobacco
12	Textiles, clothing and footwear
13	Wood products
14	Paper products
15	Printing
16	Petroleum products
17	Chemicals
18	Rubber and plastic products
19	Other non-metal mineral products
20	Cement and lime
21	Iron and steel
22	Other non-ferrous metals
23	Metal products
24	Transport equipment
25	Other equipment
26	Other manufacturing
27	Electricity generation—coal
28	Electricity generation—gas
29	Electricity generation—oil
30	Electricity generation—hydro
31	Electricity generation—other
32	Electricity supply
33	Gas supply
34	Water and sewerage services
35	Construction
36	Wholesale trade
37	Retail trade
38	Mechanical repairs
39	Hotels, cafes and accommodation
40	Road passenger transport

Industry code	Industry/commodity description
41	Road freight transport
42	Rail passenger transport
43	Rail freight transport
44	Pipeline transport
45	Ports services
46	Transport services
47	Water freight transport
48	Ship charter
49	Air passenger transport
50	Air freight transport
51	Communication services
52	Finance
53	Business services
54	Ownership of dwellings
55	Government administration and defence
56	Education
57	Health
58	Other services

Source: CIE-REGIONS database.

Table I.2 CIE-REGIONS margin services

Margin Service	Part of commodity
Gas supply	33
Wholesale trade	36
Retail trade	37
Hotels, cafes & accommodation	39
Road freight transport	41
Rail freight transport	43
Pipeline transport	44
Ports services	45
Water freight transport	47
Air freight transport	50
Finance	52

Source: CIE-REGIONS database.

Federal and state taxes

Federal taxes accounted for in the CIE-REGIONS model are:

- good and service tax (GST)
- sales taxes
- excises and levies
- labour income tax
- company income tax
- non-residents income tax
- import duties
- export taxes.

State, territory and local government taxes accounted for in the CIE-REGIONS model are:

- payroll tax
- land tax
- municipal rates
- fire surcharges
- stamp duties on:
 - insurance
 - financials
 - motor vehicle
 - residential property
 - non-residential property
 - non-residential non-real estate.

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