REPORT

CENTRE FOR
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Review of the R&D Tax Concession Program

Prepared for

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Summary

Good public policy must be appropriate, effective and efficient. This review reports on the Australian Government's 125 per cent R&D Tax Concession against these three criteria.

Central to this review is a survey of selected firms that use the R&D Tax Concession. The response rate was 30 per cent, with survey respondents making up a representative sample of the population. However, the subjective nature of the questions and the variety of roles of those answering leaves open the possibility that some answers may be misleading.

Throughout this report we have highlighted our assumptions and provided caveats wherever the data is inadequate or provides a potential bias. For two important variables (the inducement rate and the spillover rate), we do not provide a point estimate but instead offer a range in light of the ambiguity that surrounds the magnitude of those variables.

Despite these issues, this report offers a useful and informative addition to the current literature on Australia's R&D Tax Concession. In some instances, our approach and survey data have reinforced the conclusions of previous studies, while in other areas this report touches on new ground. We consider that further research is required in this area, most especially in regard to the size of knowledge spillovers.

Survey results

The survey highlighted several facts about Australia's Business R&D expenditure:

- sectors that make most use of R&D include manufacturing, followed by mining and communications;
- medium and small firms tended to have a higher R&D intensity (R&D spending as a percentage of turnover) and also had a higher export intensity (exports as a percentage of turnover);

- on average, over 90 per cent of funds appear to be sourced from the private capital market;
- most respondents indicated capital and financing to be the major constraints they faced in conducting R&D, followed by a lack of skilled labour and the company tax rate;
- the cost of patents and the inadequacy of intellectual property protection are more of a concern for small and medium sized firms;
- only about 2.5 per cent of R&D appears to be conducted internationally, with little difference between small, medium and large firms;
- the primary cost driver for R&D expenditure is skilled labour, which makes up over 40 per cent of the total cost;
- on average, firms expect R&D to contribute substantially to future sales and profits with the main focus of R&D being developing new and better products and reducing costs through process improvements; and
- firms indicated high levels of protection against having their R&D copied, mostly due to the complexity of their production process.

The Appropriateness of the R&D Tax Concession

At a macro-economic level it has long been acknowledged that technological progress is a long-term driver of economic growth. As R&D is a central cause of technological progress it follows that investment in R&D is an investment in economic growth.

While this is true, the theoretical case for government support of R&D relies on the micro-economic argument that private markets under-invest in R&D primarily because they do not factor in the social benefits of knowledge spillovers.

As outlined in more detail in chapter 2, R&D is likely to result in knowledge spillovers that provide social benefits in excess of the standard market-mediated benefits. Private investors will not take these spillovers into account, and so there is a justification for the government to introduce measures to enhance R&D – both through public R&D institutions and through incentive schemes for private R&D. On these grounds, the R&D Tax Concession scheme can be considered *appropriate*.

The Effectiveness of the R&D Tax Concession

It is not enough to justify a role for government if the government is unable to make a difference. The effectiveness of a tax concession is measured by the impact that the tax concession has on the R&D investment decisions of firms.

The effectiveness of the tax concession is measured by the inducement rate, which is how much additional R&D expenditure is made for every dollar benefit given to a firm.

Several estimates have been made previously about the inducement rate of the R&D Tax Concessions. However, previous studies were generally based on direct responses to survey questions or econometric analysis done on macro-economic data. In this report we utilised a new analytical approach which modelled firm behaviour based on their stated responsiveness to cost changes. This approach proved robust to extensive sensitivity testing, consistently providing estimates in the range of 50 to 90 per cent, with a best estimate of 69 per cent. Other approaches also tended to support an inducement rate within that range, with a 'simple model' providing an estimated inducement of 67 per cent and the 'historical method' providing an estimated inducement of 91 per cent.

An inducement rate in the range of 50 to 90 per cent can be considered relatively effective at achieving its stated aim, and so we can conclude that the R&D Tax Concession is both *appropriate* and *effective*.

The Efficiency of the R&D Tax Concession

To determine the efficiency of the R&D Tax Concession we have used a comprehensive benefit-cost analysis. As outlined in chapter 4, total costs include the direct budget cost of the tax concession, as well as the compliance cost, administrative cost and economic efficiency cost. There is also a rent-seeking cost, though this is not quantifiable. Total costs were estimated at $410 million annually.

The benefits of the tax concession were intimately linked to estimates for the inducement rate and the spillover rate. However, due to ambiguity about these variables it is not possible to provide a point estimate of either with certainty. Because of this, we have provided a matrix of results, found on page 54 of this report. Based on discussions in chapter 5, readers can conclude as to appropriate inducement and spillover estimates and thereby draw their own conclusion about the efficiency of the tax concession program.

The authors consider that a reasonable range of inducement rates is from 50 to 90 per cent, while a reasonable range for spillovers is from 30 to 130 per cent. These ranges produce a benefit-cost ratio of between 0.7 to 1 and 1.3 to 1.

Conclusion

The 125 per cent R&D Tax Concession is an appropriate and effective policy.

Insufficient evidence on the level of spillovers makes it difficult to draw a firm conclusion on the efficiency of the R&D Tax Concession. Based on current information, the authors believe that the benefit-cost ratio is likely to be close to or only slightly below 1:1. However, further research is required into the rate of spillovers from R&D. Such research is important not only for evaluating the R&D Tax Concession, but also in evaluating any government R&D program.

There was insufficient data to evaluate the 175 per cent Premium Tax Concession and the R&D Tax Offset in this report given that they have been in operation for one year only. A review of these elements might be appropriate in several years.

1 Introduction

The Australian Government has established a number of R&D funding support programs aimed at increasing the level of R&D in Australia. The backbone of these programs is the R&D Tax Concession program, which is made up of the 125 per cent R&D Tax Concession, the 175 per cent Premium Tax Concession and the R&D Tax Offset. Over 4000 businesses take advantage of the tax concession scheme, which costs the government around $400 million a year. This cost is expected to rise to over half a billion by 2005-06 (Commonwealth of Australia, 2003).

Ensuring these resources are invested where they provide significant national economic benefits is a major policy issue. This study looks at the appropriateness, effectiveness and efficiency of the 125 per cent R&D Tax Concession.

Outline of the R&D Tax Concession program

The purpose of the R&D Tax Concession is to encourage firms to undertake more R&D in Australia, to the benefit of the wider Australian economy. According to the IR&D Board's 2001-02 Annual Report the main objectives of the tax concession are:

- increase investment in R&D activities;
- encourage the development of innovative products, processes and services;
- promote technological advancement through a focus on innovation and high technical risk in R&D;
- encourage the use of strategic R&D planning; and
- create an environment that is conductive to increased commercialisation of new processes and product technologies.

The R&D Tax Concession is the government's primary program to encourage private firms to undertake R&D. It is the most widely utilised Australian Government R&D program. According to AusIndustry's latest customer satisfaction survey, 93 per cent of R&D Tax Concession recipients are satisfied with the overall delivery of the tax concession scheme.

Who can get the R&D Tax Concession?

To be eligible for the R&D Tax Concession a firm must pass several criteria, including:

- a minimum expenditure threshold of $20 000 (unless the work is contracted to a Registered Research Agency);
- entity must be a company incorporated in Australia or a public trading trust, and must generally carry out their R&D activities in Australia;
- R&D activities must be for the benefit of the Australian economy;
- a company's R&D must be undertaken on it's own behalf;
- R&D activities must be supported by an R&D Plan (this requirement applies only to activities that commenced after 30 June 2002); and
- must be conducting R&D, as defined in Section 73B of the *Income Tax Assessment Act 1936*.

The Income Tax Assessment Act explains that R&D activities means 'systematic, investigative and experimental activities that involve innovation or high levels of technical risk' with the purpose of acquiring new knowledge or creating new outputs. The government has provided guidance on what does and does not classify as R&D. Table 1.1 below outlines which activities and expenditures are specifically included and excluded. Activities not considered as core R&D can still be claimed if they are directly related to the carrying on of the R&D as a 'supporting' activity.

In some cases the definition of R&D will be open to interpretation, and this can lead to uncertainty for firms about whether certain activities will be eligible for the tax concession.

Administering the R&D Tax Concession

A company cannot claim the R&D Tax Concession unless it is registered with the Industry Research and Development (IR&D) Board. To be registered a company must lodge an application form with the Board within 10 months of the end of the year of income in which the qualifying expenditure on R&D activities was incurred.

1.1 What constitutes R&D?

Activities not considered core R&D

- Market research, market testing or market development, or sales promotion (including consumer surveys);
- Quality control;
- Prospecting, exploring or drilling for minerals, petroleum or natural gas for the purpose of discovering deposits, determining more precisely the location of deposits or determining the size or quality of deposits;
- The making of cosmetic modifications or stylistic changes to products, processes or production methods;
- Management studies or efficiency surveys;
- Research in social sciences, arts or humanities;
- The making of donations;
- Pre-production activities, such as demonstration of commercial viability, tooling-up and trial runs;
- Routine collection of information, except as part of the research and development process;
- Preparation for teaching;
- Commercial, legal and administrative aspects of patenting, licensing or other activities;
- Activities associated with complying with statutory requirements or standards, such as the maintenance of national standards, the calibration of secondary standards and routine testing and analysis of materials, components, products, processes, soils, atmospheres and other things;
- Specialised routine medical care; and
- Any activity related to the reproduction of a commercial product or process by a physical examination of an existing system or from plans, blueprints, detailed specifications or publicly available information.

Expenditures included as R&D

- Salaries expenditure, including wages, salaries, bonuses, overtime and penalty rates, annual leave, sick and long service leave, superannuation fund contributions, payroll tax, workers' compensation premiums and other labour costs directly associated with the R&D activities.
- Other expenditure incurred directly in respect of R&D activities carried on by or on behalf of the company, eg overheads and administrative costs (or an apportionment of these costs) such as rent, light and power, property rates and taxes, insurance and leasing costs.
- Expenditure on plant acquired or commenced to be constructed before 29 January 2001 may be claimable over a three year period at the rate of 125 per cent, if it is acquired for use exclusively in carrying on R&D activities for an initial period, and actually used exclusively for that purpose throughout the year.
- Pilot plant acquired before 29 January 2001 may attract a 125 per cent deduction based on useful life depreciation, subject to the above exclusive use test.
- For assets acquired or commenced to be constructed after 29 January 2001, a 125 per cent deduction may be available on effective life depreciation of the plant, for the period of R&D use, ie companies that use an item of plant only partially for RD are now able to claim the concession for that portion of use.
- Interest expenditure, or an amount in the nature of interest, incurred in financing R&D activities, which is deductible at a rate of 100 percent, unless incurred under a fixed-term contract entered into prior to 23 July 1996
- A deduction for core technology expenditure is allowable at a rate of 100 per cent to a maximum of one-third of the amount of R&D expenditure in the relevant year on R&D activities that are based on the core technology.
- A deduction for feedstock expenditure is limited to the net cost of the feedstock. This is achieved by subtracting the value or sales proceeds of any products derived from processing or transforming feedstock as part of the R&D activities from the cost of the feedstock that was used in the process.

Source: AusIndustry, 2002. Information on activities included is derived from ATO rulings IT2442, IT2451 and IT2552.

The R&D Tax Concession is administered jointly by the IR&D Board and the Australian Taxation Office (ATO). Ministerial responsibility for the tax concession rests with the Minister for Industry, Tourism and Resources.

The IR&D Board through AusIndustry maintains a database of registrants, determines whether R&D activities are eligible for the tax concession and provides assistance to the tax concession recipients where possible. The ATO uses advice from the IR&D Board to determine whether R&D activities are eligible and also provides advice and assistance to taxpayers on R&D expenditure issues.

How the R&D Tax Concession works

The R&D Tax Concession works by decreasing the after-tax cost of investing in R&D, thereby making R&D a more attractive investment to business.

In an economic sense, the impact of the R&D Tax Concession is to lower the marginal cost of conducting R&D. Given the Australian company rate of tax of 30 per cent and a 25 per cent tax concession, for a firm the concession is generally equivalent to lowering the costs of deductible R&D inputs by 7.5 per cent (0.3*0.25= 0.075). Because of the decrease in the effective cost of R&D, businesses will be encouraged to increase their level of investment.

In addition to this first round effect (7.5 per cent reduction in R&D costs) there may be reasons to think that the R&D Tax Concession results in other changes that slightly alter the incentive. One of the effects of tax is to artificially bias investment decisions away from current-income projects and towards delayed-income projects (Treasury, 2001). As the tax concession slightly reduces the total amount of tax, then it is slightly reducing this bias and will make current-income projects look marginally more favourable than delayed-income projects. As R&D is more likely to be a delayed-income project, this effect may work to marginally reduce the incentive effect below 7.5 per cent.

Another effect is due to the time value of money. While the tax concession scheme does reduce the amount of tax paid by a firm, it does not necessarily return the tax money immediately. Because money today is worth more than the same amount in the future, in instances where the tax is refunded after the R&D costs have been incurred the tax concession is worth less than its full face value. On the other hand, to the degree that the tax concession scheme allows companies to declare their costs earlier than they otherwise would (and subsequently receive their tax concession earlier), the tax concession would be worth more than its face value. This was especially true when companies were allowed to use accelerated depreciation for plant, but since the 2001 reforms this has not been the case.

However, while there may be reasons for believing that the true incentive effect is different from 7.5 per cent of the costs of R&D – it is not likely to be significantly different.[1] Further, the methodology used for determining inducement is based on the elasticity and so is not sensitive to the assumed rate of incentive.

The above calculations apply to the 125 per cent R&D Tax Concession. The incentive will be different for R&D that is eligible for the 175 per cent Premium Tax Concession. Using the same methodology as described above, the Premium Tax Concession offers an incentive equivalent to lowering the costs of deductible R&D inputs by 22.5 per cent.

Changes to the R&D Tax Concession

The R&D Tax Concession was introduced at the rate of 150 per cent on 1 July 1985 and was initially intended to be a six-year temporary measure. The program has continued on in some form since that time, while being adjusted in 1987, 1989, 1992, 1994, 1995, 1996, 1998 and 2001.

In the most recent reforms, four changes were made. These are:

- the introduction of the 175 per cent Premium (Incremental) Tax Concession for additional investment in R&D;
- the introduction of an R&D Tax Offset (also referred to as a Rebate) for small companies in tax loss that undertake R&D, enabling them to 'cash out' their R&D tax losses;
- a requirement that eligible R&D activities must be supported by an R&D Plan (effective from 1 July 2002); and
- a new treatment of R&D plant-asset depreciation that allows a 125 per cent deduction for effective life depreciation of assets used in R&D activities (on a pro-rata basis).

Because of the many changes over the years it will not always be appropriate to compare the results of this analysis with the results of previous studies. In addition to the many rule changes (such as the removal

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[1] In some applications of the tax concession incentive it is necessary to consider the issue of tax and franking. A 7.5 per cent benefit is equivalent to a 10.7 per cent pre-tax benefit. However, as this benefit is passed on to shareholders as an unfranked dividend, shareholders must pay tax on the benefit and so 7.5 per cent can be understood to represent the pre-tax benefit.

of syndication in 1996), changes in the level of the R&D Tax Concession and the level of company tax means that in different years the tax concession provided very different incentives.

1.2 **Evolution of the R&D Tax Concession nominal incentive effect**

Year	*Tax concession rate*	*Company tax rate*	*Nominal Incentive effect*
1985	150	46	23
1986	150	49	24.5
1988	150	39	19.5
1993	150	33	16.5
1995	150	36	18
1996	125	36	9
2000	125	33	8.25
2001[a]	**125**	**30**	**7.5**
2001[b]	**175**	**30**	**22.5**

[a] 125 per cent R&D Tax Concession. [b] 175 per cent Premium Tax Concession.

Previous review of the R&D Tax Concession program

There have been several reviews of the Australian R&D Tax Concession in recent years, including a Department of Industry, Science and Resources/Allens report (2000), reports by the Industry Commission (1995, 1997) and the Bureau of Industry Economics (1993). It is worthwhile reviewing some of the findings from these studies.

2000 DISR–Allens report

The most recent review of the R&D Tax Concession, and the predecessor to this review, is the 2000 DISR–Allens report. This survey-based analysis was largely qualitative and no net benefit or rate of return was reported.

1997 Industry Commission Review – Ralph Lattimore

The author of the 1997 Industry Commission Review found that when he used his preferred estimates, *'the social rate of return to the 125 per cent tax concession is strongly positive'* (p. 115). The report indicated that there was a 75 per cent probability that the R&D Tax Concession is welfare-enhancing, with a mean social rate of return estimated at 32 per cent and a median social rate of return of 27 per cent.

1993 Bureau of Industry Economics

The 1993 BIE Book 'R&D, Innovation and Competitiveness: An evaluation of the research and development tax concession', evaluates a R&D Tax Concession of 150 per cent. This report found the tax concession to provide a marginal net benefit, with the $223 million program providing a net benefit of $22 million. This equates to a benefit–cost ratio of 1.1 to 1, and ranging between 0.95 and 1.25 to 1.

The scope of this report

The Centre for International Economics (CIE) was engaged by the Australian Government, through the Department of Industry Tourism and Resources (DITR) to conduct an evaluation of the program's performance.

The objective of the review is to focus on measuring the economic impacts (including spillover benefits) of the R&D Tax Concession program and its contribution to Government innovation policy. Necessary parts of this review include:

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

The broad approach in this review

This review develops a framework for measuring the overall national benefits and costs from the R&D Tax Concession. Information is gathered from previous studies, from our survey of tax concession recipients and from our economic model of R&D. This is compiled using a comprehensive benefit–cost framework. It should be noted that the benefit–cost ratio is applied only to the 125 per cent R&D Tax Concession and not to the other components of the scheme.

This report has six chapters, followed by appendices with greater detail on various topics. The next chapter reviews the rationale for government intervention in R&D — including a discussion of spillovers and the macroeconomic evidence of the benefits of R&D. In chapter 3 we discuss the results from our survey of R&D Tax Concession recipients and will build up our micro-economic understanding of the role of R&D.

Chapter 4 looks at the cost of the tax concession program, including the fiscal costs, compliance costs, administration costs, efficiency costs and rent-seeking costs. Chapter 5 reviews the evidence of the impact of the tax concession on R&D – how much additional research was undertaken and what benefits (private and public) flow-on from this additional research. The final chapter brings this information together in a comprehensive benefit–cost framework and draws conclusions about the appropriateness, effectiveness and efficiency of the R&D Tax Concession program. Details on the benefit–cost framework used can be found in appendix A.

2 *Rationale for government support*

Before analysing the costs and benefits of the R&D Tax Concession program it is necessary to explore the theory behind the program and the rationale for government support. Governments in Australia have made the decision to support R&D — both through public research institutions such as the Commonwealth Scientific & Industrial Research Organisation and the Defence Science and Technology Organisation, and through incentives to private firms such as the R&D Tax Concession, the R&D START program and various other programs. This support is based on the belief that supporting R&D will provide a net social benefit to Australia.

The macroeconomics of R&D

At the macroeconomic level, R&D appears to play a vital part in producing economic growth. In their 1995 report on R&D, the Industry Commission stated that 'both economic theory and empirical analysis suggest that technological progress has the potential to be a major contributor to economic growth in any country'. R&D is widely assumed to be a major contributor to technological progress.

In growth theory, national incomes are dependent on the amount of labour, the amount of capital (including human capital) and the level of technical innovation. Due to decreasing returns to capital and labour, long term economic growth must be a result of growth in technology. As R&D leads to new technology, R&D is a driver of long term economic growth and is therefore vital to the economic interests of a nation.

Several econometric studies have looked at the impact of R&D on the economy and have found high social rates of return from R&D investment. Dowrick (2002) reports that social rates of return for R&D have been estimated at about 50 per cent. It is not uncommon for commentators to conclude that R&D is the driver of economic growth and therefore, if we want more economic growth we should encourage more R&D.

It is noted that Australia's Business Expenditure on Research and Development (BERD) is relatively low compared with other developed nations. This must be considered in light of Australia's relatively high level of public investment in R&D and the fact that the manufacturing industry (which is R&D intensive) makes up only 13 per cent of Australia's Gross Domestic Production (ABS).

However, the debate about what Australia's BERD should be cannot be resolved with macro-economic information. While R&D investment provides economic benefits, so do other investments. To maximise economic returns we want to have the right mix, and to understand the resource allocation between different investment opportunities we need to understand the micro-economics of R&D.

Basically, unless we have reason to believe that the private markets will under-invest in R&D there is no need to encourage additional business R&D. Most analysts do believe that the private market will under-invest in R&D, primarily because of the existence of knowledge spillovers.

Why private market under-invests in R&D — spillovers

In short, the reason the free market under-invests in R&D is that, while the social returns from R&D are relatively high, the private returns are not as high and so private firms will be more likely to invest in other projects (which may not have high social returns). A review of research into returns to R&D by Dowrick (2002) found that private returns to R&D are around 25 per cent in the United States, but social returns to R&D are around 50 per cent. Other studies have found similar results. There are two reasons why private returns do not match social returns — the existence of *flow-on benefits* and *spillover benefits*.

Flow-ons

Flow-on benefits are the 'market-mediated' outcomes that flow-on from:

- the value of the purchased product or service to business and household consumers; and
- the changes in economic activity for input suppliers and competitors, which can be positive or negative.

Flow-on benefits exist in all market activity. It is important to note that the existence of flow-on benefits does not justify government intervention.

Indeed, it is the very existence of flow-on benefits that makes the market system work (see box 2.1). It is for this reason that we will refer to 'market mediated' benefits as the sum of the firm's benefits and the flow-on benefits.

2.1 The link between private benefits and flow-on benefits

The benefits of the market system are often misunderstood. The market system was never intended to be a system that only maximised firm profits. In fact, the very reason that the first proponents of capitalism started to promote the market system was that they believed it would lead to higher social benefits. The reason for this is the link between private benefits and flow-on benefits — linked by what Adam Smith called the *invisible hand*.

Smith outlined how, in a market system dominated by businessmen trying to make profits, their actions would 'accidentally' result in the highest level of social benefits. This is because firms would compete to offer their customers the most benefit. This benefit to the consumer is what we now call *flow-on benefits*. In maybe his most famous line, Smith pointed out that 'it is not through the benevolence of the butcher or baker that we receive our lunch, but out of their regard for their own wellbeing'. What he was pointing out is that every market transaction produces flow-on benefits.

Picking winners on the basis of flow-ons is often inappropriate

All forms of investment and economic activity generate flow-ons. Shifting resource away from one activity (by taxing it to raise a subsidy) to another activity, R&D (by subsidising it with those funds), will reduce flow-ons in the taxed sector but raise them in the subsidised sector. The net gain is likely to be zero. Only if flow-ons plus private benefits are larger in one than the other will there be a net benefit. Flow-on effects are highly complex, and although we can measure them in broad terms for different sectors, picking winners has long proved to be costly for the many economies that have tried.

The reason that R&D is likely to have higher social benefits than other investments is not because it has higher flow-on benefits, but that R&D also produces *spillover benefits.*

Spillovers

Spillover benefits are the additional non-market-mediated benefits that are not captured by the firm producing them, or by the firm's customers, but which flow over to the wider economy in the form of:

- knowledge or a platform technology that allows or spurs innovations to occur in other industries, for instance, resulting in the development of other products, services or processes in Australia;
  - these knowledge spillovers are difficult to appropriate because the goods or services produced are non-rival and possibly accumulative in nature, meaning:
    - … people can simultaneously consume the same product (say an idea) without depleting it or without excluding others from using it, and
    - … as people use it or as more people use it, its accumulated use may become more valuable, as occurs with a computer network;
- economies of scale or scope that might arise from cluster economies formed or contributed to by the firm's activities; and
- improvements in occupational health and safety or pollution.

Spillovers are benefits that are not accounted for in the decisions of the investors, but nevertheless generate positive outcome for the economy as a whole. Unlike flow-on benefits, spillover benefits are not common to all investment decisions and are not accounted for by the market process. Because these benefits are not factored into private firm decision making, private firms are likely to under-invest in R&D and government intervention may be justified.

One way that the government attempts to account for knowledge spillovers is through the patent system. By allowing firms to patent their new ideas the government is allowing private firms to capture some amount of the spillover benefit. However, patents are not easily applied to all outcomes of R&D. Consequently, the government funds public R&D and maintains various programs to increase the level of private R&D.

Inability to distinguish between flow-ons and spillovers may be a problem

In practice, flow-on and spillover effects may be difficult to distinguish. Most studies into R&D have not attempted to distinguish between the two, and often simply refer to all non-private benefits as the public benefit or the externality.

While it is true that both flow-ons and spillover benefits are public benefits, the difference between the two concepts is important in determining the existence and extent of market failure. By treating flow-ons in the same way as spillovers, some previous studies have overstated the market failure. In this report we will attempt to distinguish between flow-on and spillover benefits.

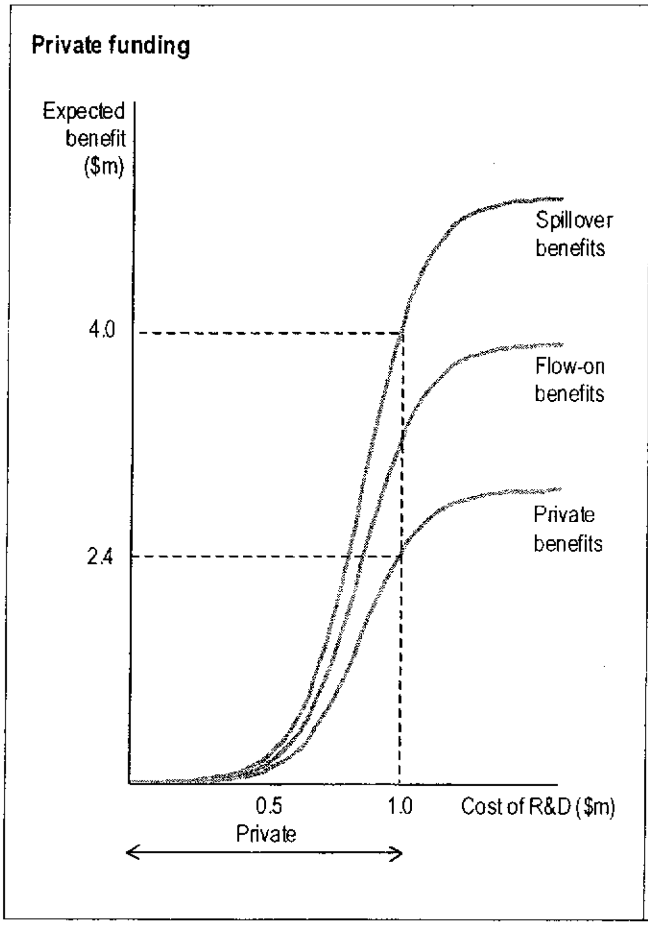
An example of the effect of spillovers

The spillover argument for government intervention is maybe best illustrated with an example. Charts 2.2 and 2.3 plot a purely hypothetical relationship between R&D spending (on the x-axis) and R&D benefits (on the y-axis).

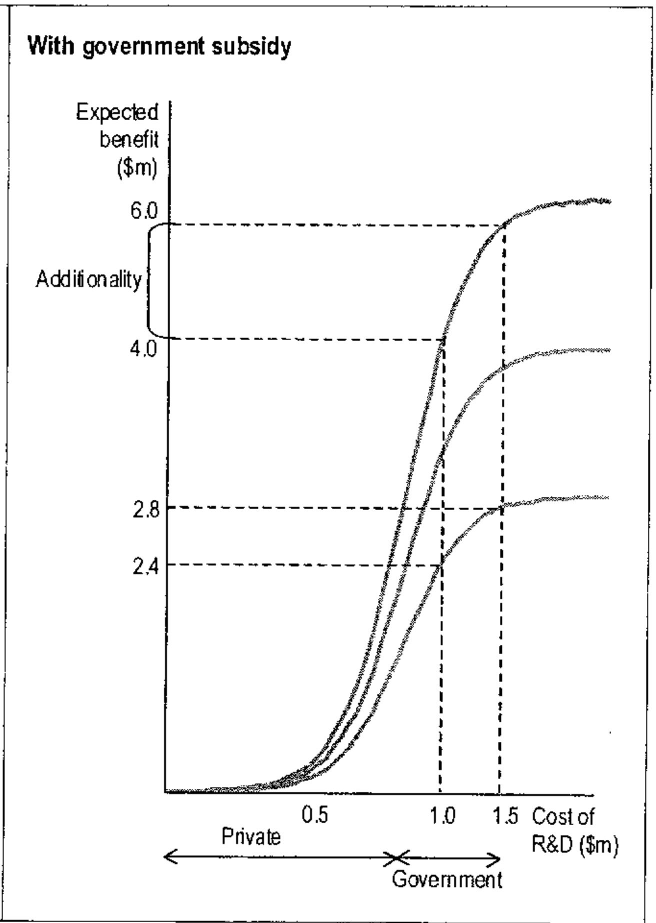
Private benefits

As can be seen in chart 2.2, at low levels of investment ($0.5 million), little or no benefit is gained. This is because there is a certain minimum investment required to achieve a critical mass necessary to get any benefits

2.2 **B:C relationship: private funding only**



2.3 **B:C relationship: with government subsidy**



from R&D. However, once the point of critical mass is reached ($0.5 million in chart 2.2), then the additional R&D spending (an additional $0.5 million) produces significant private benefits. In the example in chart 2.2, the additional $0.5 million investment in R&D produces $2.4 million additional private benefit. At this point, the average private return is 2.4 to 1.

It should be noted that if R&D spending is increased beyond $1.0 million in chart 2.2, the private benefit receives diminishing marginal returns to R&D. The firm will continue to invest in additional R&D until their marginal return from the R&D is 1:1. If the firm increases investment beyond that point, it will start to invest in projects with a negative return.

Flow-on and spillover benefits

Also shown on chart 2.2 are the additional flow-on and spillover benefits that come from private investments in R&D. The combination of these three benefits make up the social return on the R&D investment. As can be seen in chart 2.2, the average social return on the $1 million is $4 million.

However, at $1 million R&D investment the social return is still receiving positive marginal returns. That is, it is socially optimal for more R&D to be undertaken, but the private firm has no incentive to do any further R&D because they have reached the point of decreasing marginal returns.

The introduction of a government program

Recognising that the private outcome is sub-optimal, the government may introduce a new program that encourages private firms to invest in R&D (such as the R&D Tax Concession) by lowering R&D costs to the firm. In response to the new government program, the private firm will invest in more R&D. This can be seen as the expansion of R&D investment in chart 2.3, from $1 million to $1.5 million.

Note that the additional $0.5 million investment in R&D produced an additional $2 million in social benefits (the difference between $6 million and $4 million in chart 2.3). However, the private firm would never have made this investment without government incentives because the private return from the additional $0.5 million investment was only $0.4 million (the difference between $2.8 million and $2.4 million in chart 2.3).

Inducement effect from the government program

The bottom of chart 2.3 shows that the government had to provide more than $0.5 million to the private firm to induce an additional $0.5 million.

This is because only part of the R&D assistance will induce extra R&D, while some of that assistance will simply be absorbed by the firm. In the example below, if we assume that the government gave $0.7 million worth of assistance and that induced an additional $0.5 million, then we would have an inducement rate of 0.5/0.7 = 70 per cent.

Determining the benefits of the government program

In determining the value of a government R&D program it is important to distinguish between the total benefit from the R&D and the additional marginal benefits for the Australian economy caused by the contribution of induced R&D. It is only the benefits of the induced R&D that should be recorded as a benefit to the government program.

Spillovers of themselves are not an argument for government intervention

The mere existence of possible spillover benefits in a potential R&D project does not necessarily imply that government intervention will be good policy. The existence of spillovers shows that a government R&D program (such as the R&D Tax Concession) may be appropriate. However it is still necessary to show that such a program is effective (makes a difference) and efficient (produces more benefits than costs).

Even if there are significant R&D spillovers, if the R&D Tax Concession is not effective at encouraging additional R&D spending or if the costs of that R&D spending exceed the benefits of the program, then it should be reformed or removed. The effectiveness of the R&D Tax Concession will be discussed in chapter 5 and chapter 6 will consider the efficiency of the program in a comprehensive benefit–cost framework.

Other rationales for government intervention

The main rationale for government intervention is the existence of spillovers. However, over the years several other potential reasons for government spending have been introduced.

One theory is that the capital market may be unwilling to get involved in R&D investments that it considers too risky or where it is unable to assess the risk involved (because researchers may require secrecy about their projects). The market solution to this problem is that the capital markets should attempt to diversify into many high-risk and high-return projects and the average return should be positive. Indeed, this is what venture capitalists attempt to do. However, it is possible that venture capitalists are unable to efficiently diversify their risks and therefore could be under-investing in R&D.

Another potential reason for under-investment in R&D is that start-up R&D firms have a lack of information or inadequate communication channels which limits their access to funds. While this is undoubtedly true, the same is probably true for non-R&D start-up firms. However, it could be argued that the information and communication requirements of firms grows significantly as the riskiness of their business grows, and so start-up R&D firms are at a competitive disadvantage.

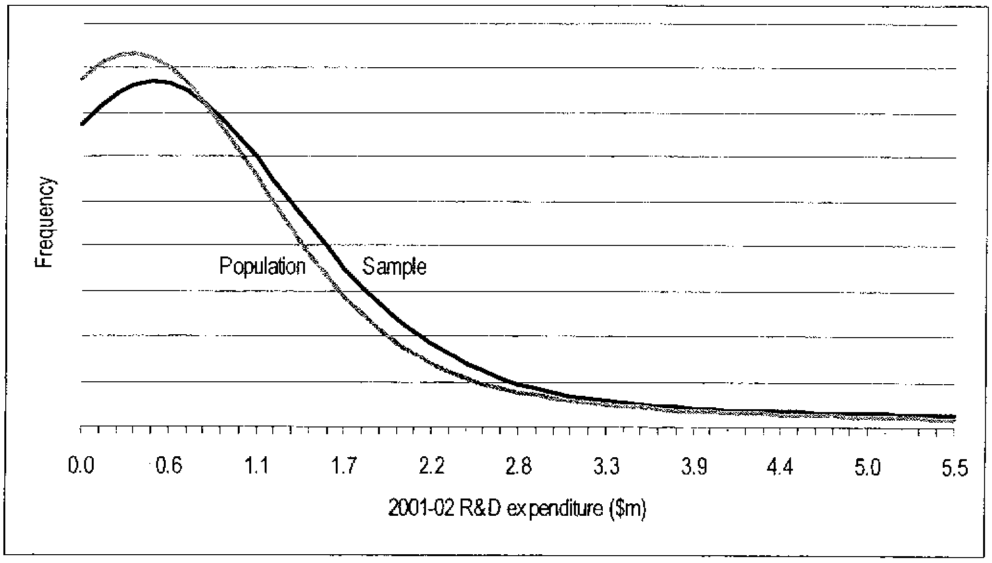
3 Overview of survey results

The survey was sent to some 2500 firms. Around 30 per cent responded, giving a sample of 744. Chart 3.1 shows the distribution of sampled firms' R&D expenditure relative to that of the population of all firms that participated in the R&D Tax Concession. In terms of R&D expenditure, the sample appears to be a good representation of the population. More details on the representativeness of the survey is provided in Appendix D.

For the purposes of the survey design we stratified the sample into three groups on the basis of their R&D expenditure. All three groups responded similarly to the survey, with a slightly higher response rate from firms that did over $1 million worth of R&D.

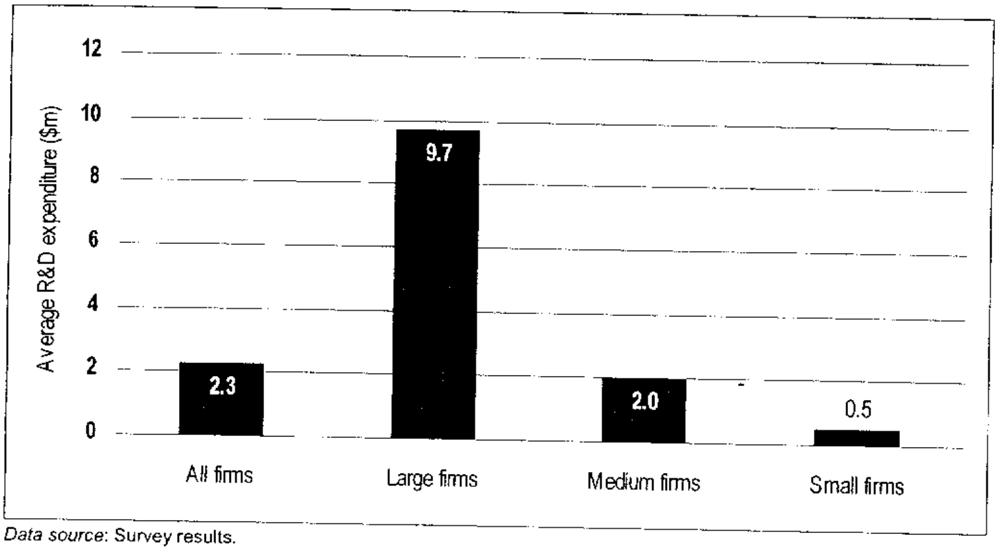
However, for the purposes of analysis we defined three different groups of firms. Large firms are those with more than 200 employees, medium sized firms are those with more than 20 and less than 200 employees, and small firms are those with fewer than 20 employees. It is also possible to classify firm size on the basis of turnover. Some limited information is available on classification by turnover in Appendix D.

3.1 **Distribution of R&D expenditure**



Data source: Survey results.

3.2 **R&D expenditure**



Data source: Survey results.

Chart 3.2 sets out the average R&D expenditure of respondents by firm size. As would be expected, large firms tended to spend more on R&D.

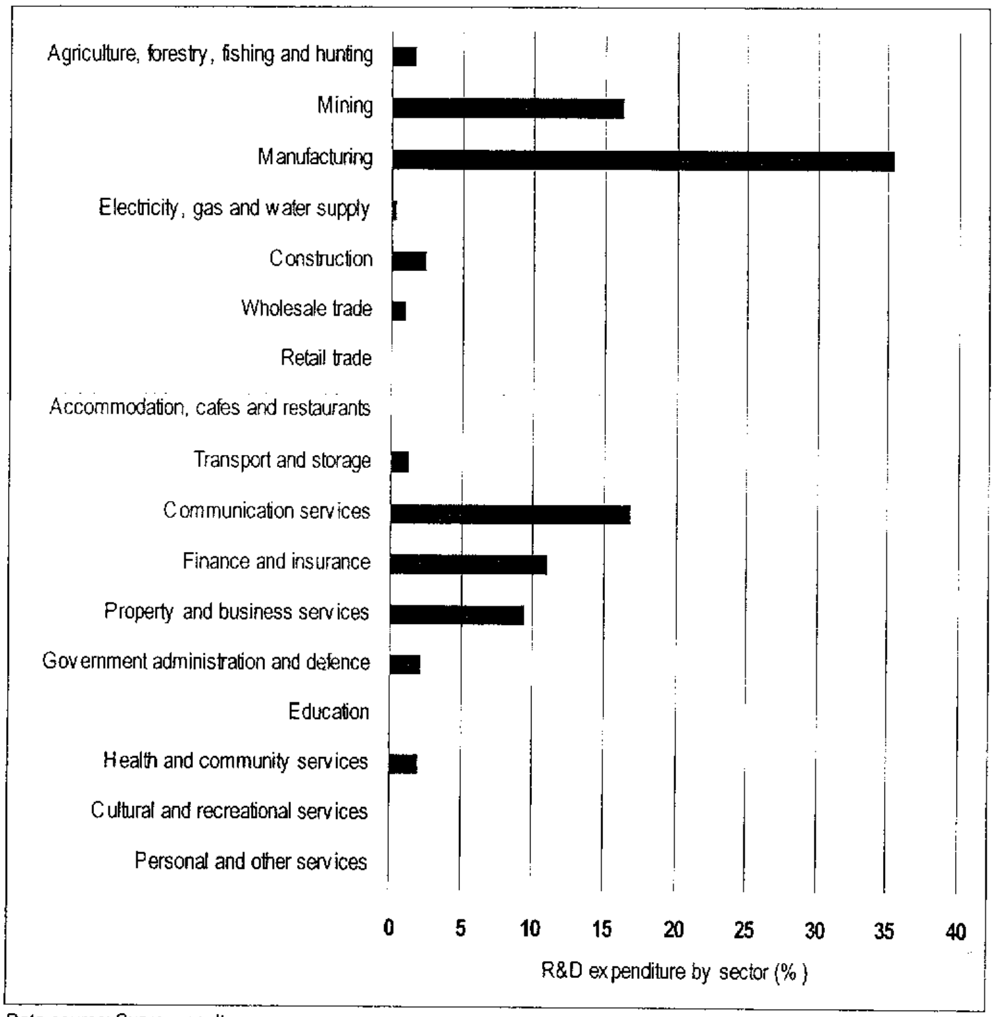
The breakdown of R&D expenditure of the sample into different sectors is set out in chart 3.3. There is considerable variation in R&D expenditure, with some sectors, such as retail trade, accommodation and cultural services recording insignificant amounts of R&D. The largest R&D sector by far was manufacturing, following by mining and communications.

The R&D intensity (R&D expenditure as a percentage of turnover) by firm size is set out in chart 3.4. While large firms tended to invest more in R&D, they also tend to have lower R&D intensity than medium and small firms. Medium and small firms also tend to have export intensities higher than the average and tend to have a higher proportion of business customers relative to household customers (chart 3.5 and 3.6).

All firms tend to have high levels of skilled labour (chart 3.7). In the case of small and medium sized firms, skilled labour makes up over 60 per cent of their total labour force.

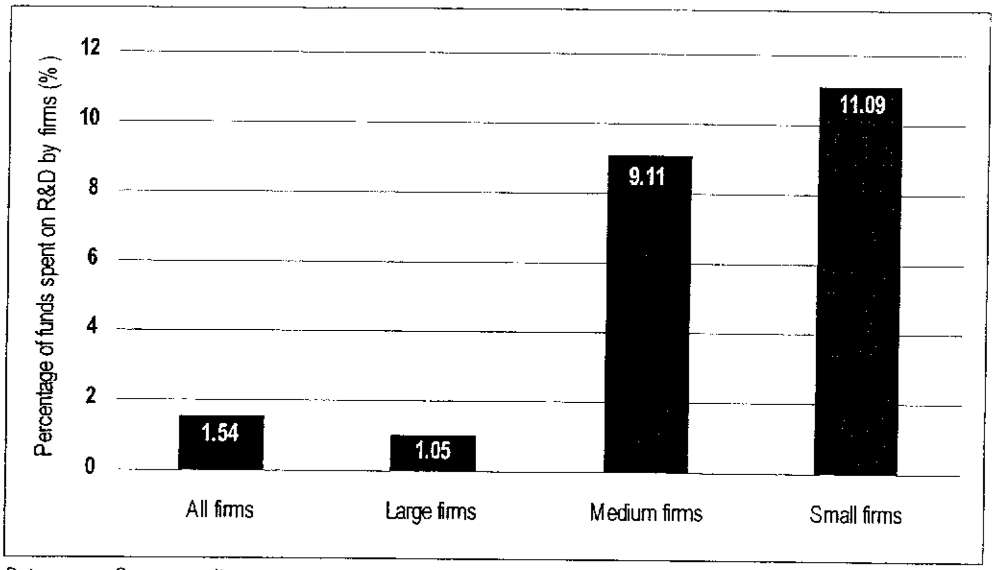
Previous and current use of other government programs is set out in charts 3.8 and 3.9. Around 10 per cent of firms using the tax concession have previously benefited from the R&D START program (primarily small and medium firms) and state government support, while nearly a quarter of current tax concession recipients have previously made use of the export market development grant. About 15 per cent of firms indicated that they are currently benefiting from export market development grants.

3.3 Sectoral composition of R&D expenditure (by ANZSIC codes)



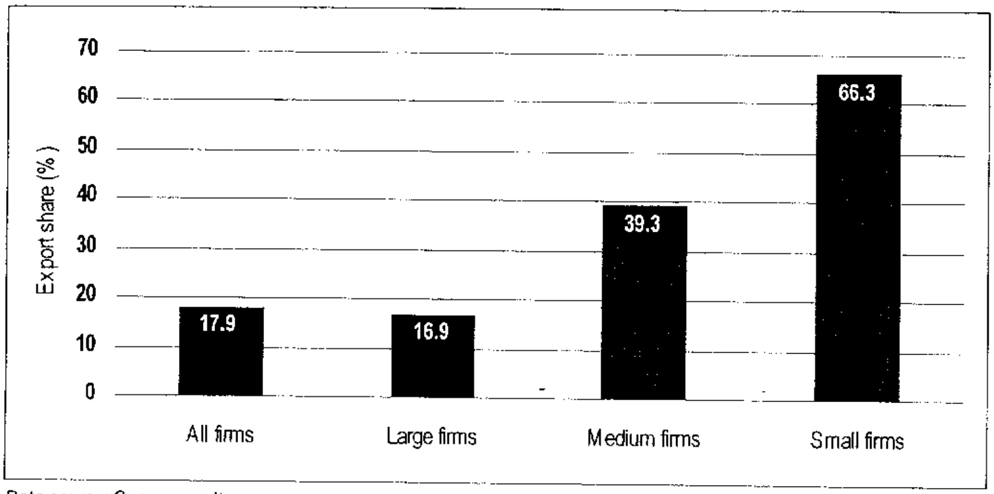
Data source: Survey results.

3.4 R&D intensity by firm size (% of turnover)



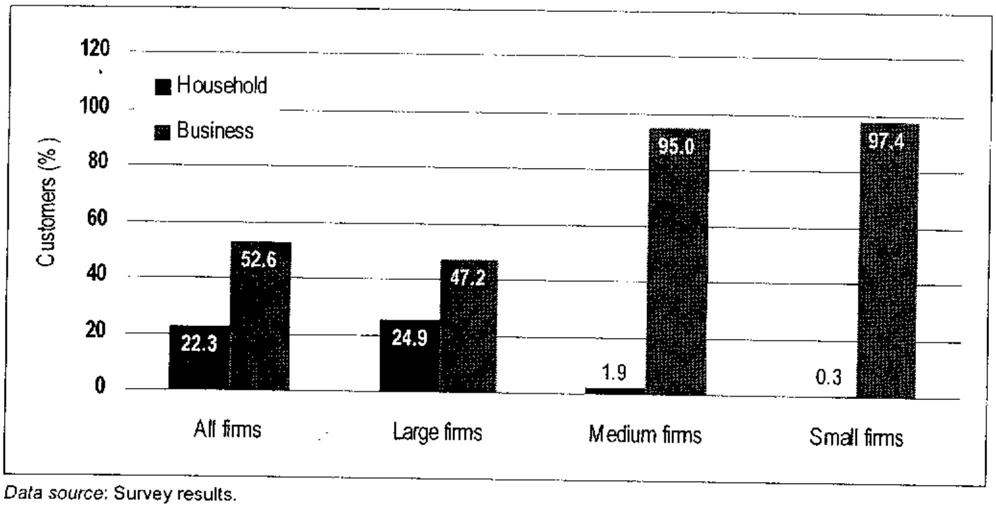
Data source: Survey results.

3.5 **Export share by firm size (% of sales)**



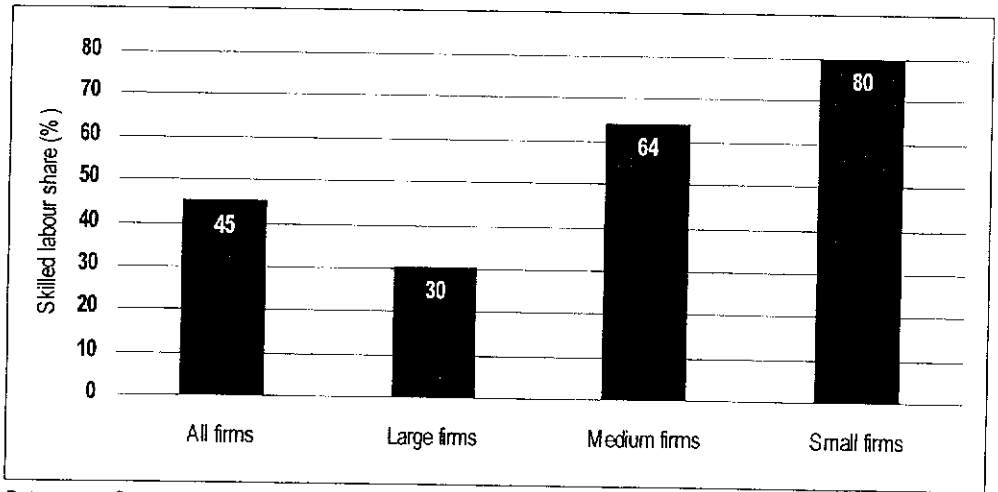
Data source: Survey results.

3.6 **Customers by firm size**



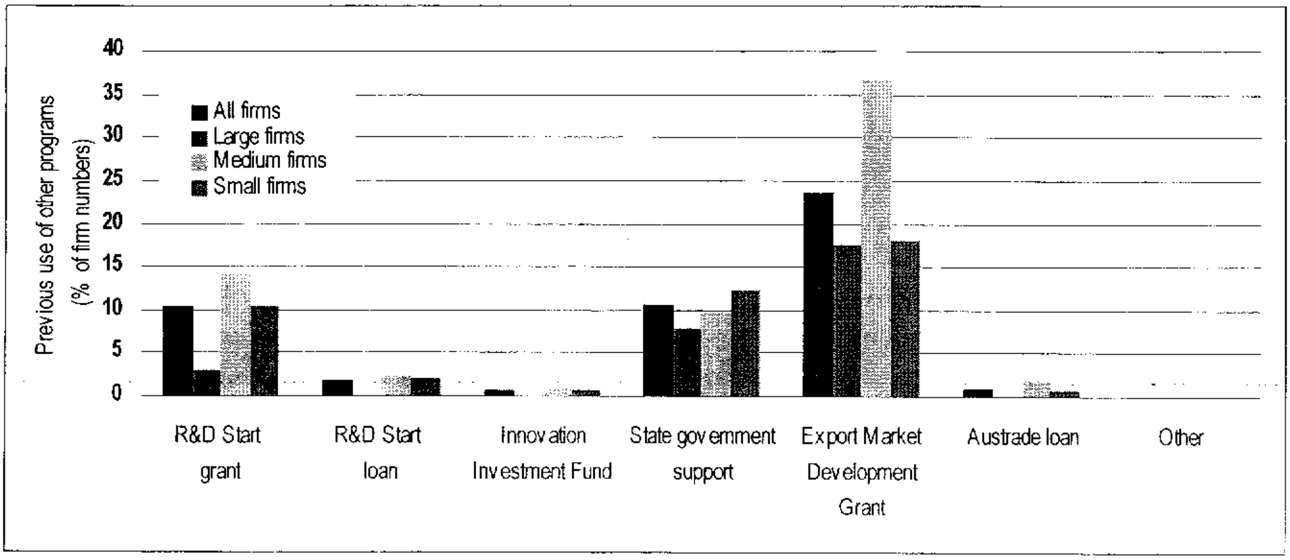
Data source: Survey results.

3.7 **Skilled labour by firm size**



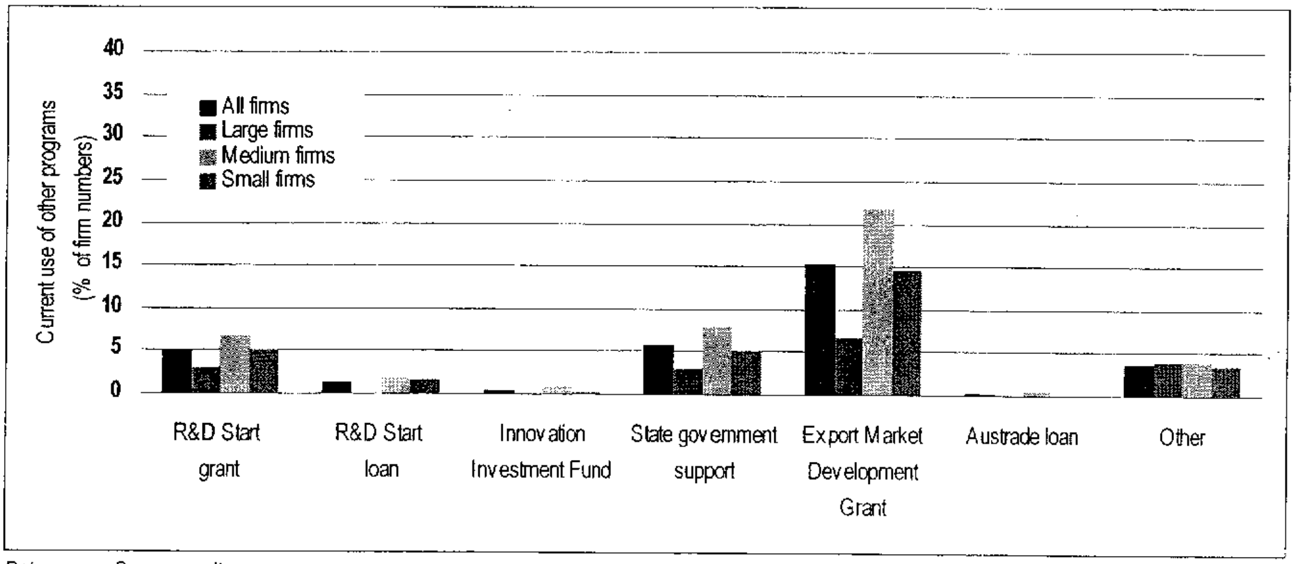
Data source: Survey results.

3.8 Previous use of other programs as a percentage of firm numbers



Data source: Survey results.

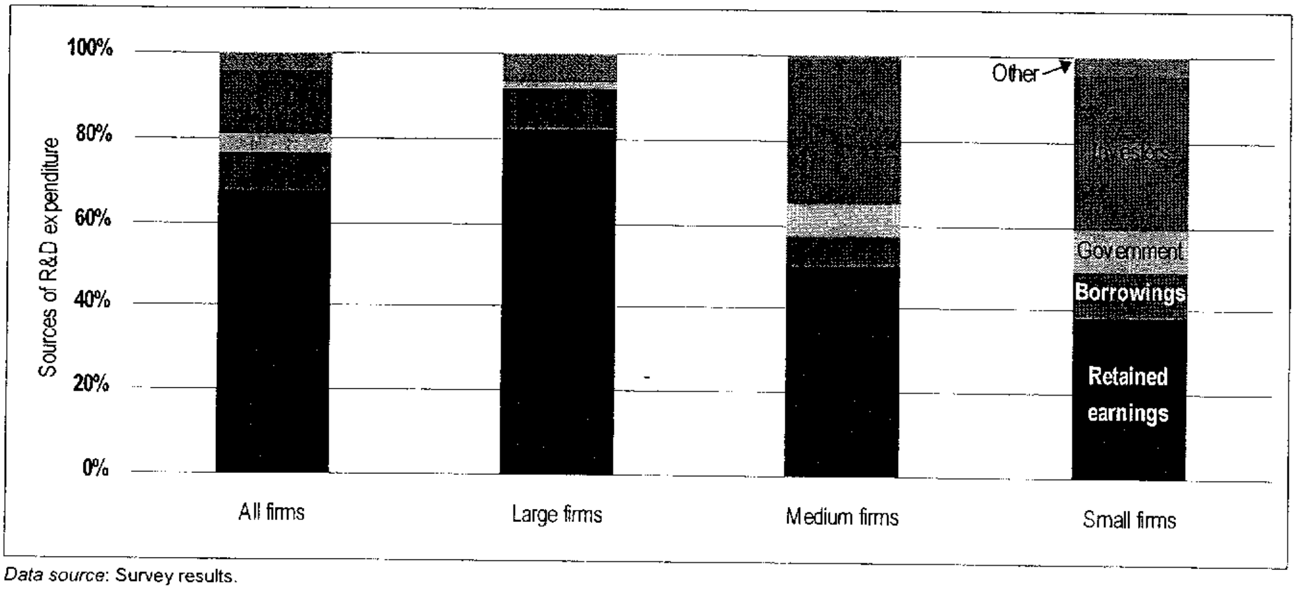
3.9 Current use of other programs as a percentage of firm numbers



Data source: Survey results.

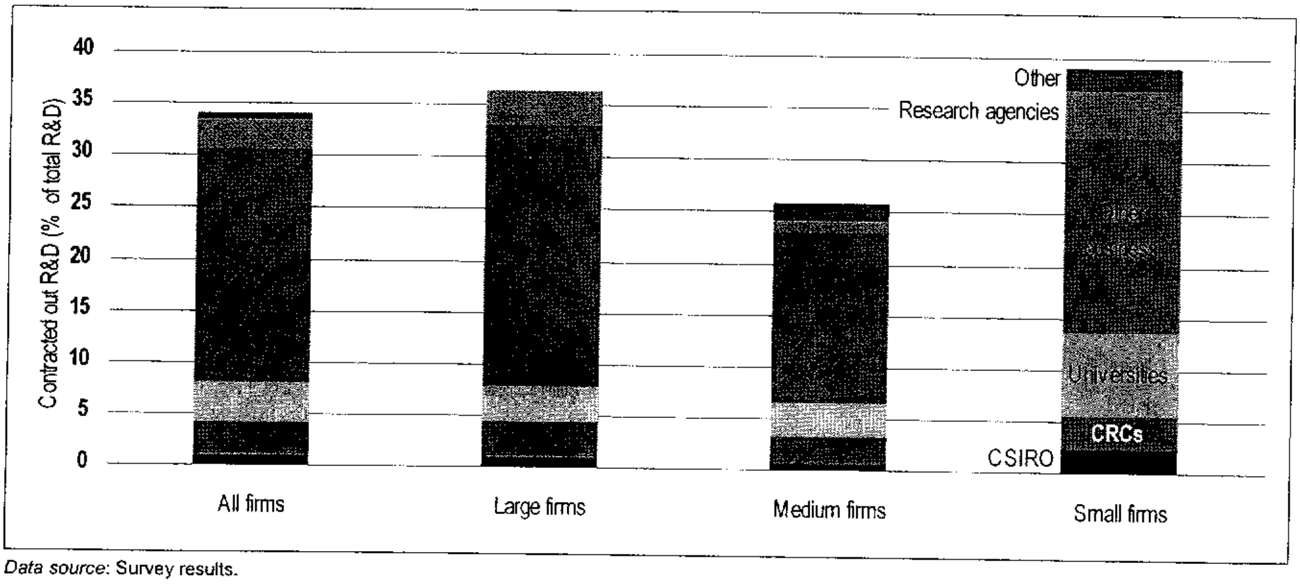
The sources for R&D funding are set out in chart 3.10. On average, over 90 per cent of funds appear to be sourced from the private capital market, with only a minority of funds coming from the government. Government funds make up about 5 per cent of funds for small and medium firms. Small and medium firms are also more reliant on private investors while large firms primarily finance their R&D through retained earnings. Debt financed R&D expenditure contributes roughly 10 per cent to all firms irrespective of size, indicating relatively robust access to credit.

3.10 **Sources of R&D expenditure**



Data source: Survey results.

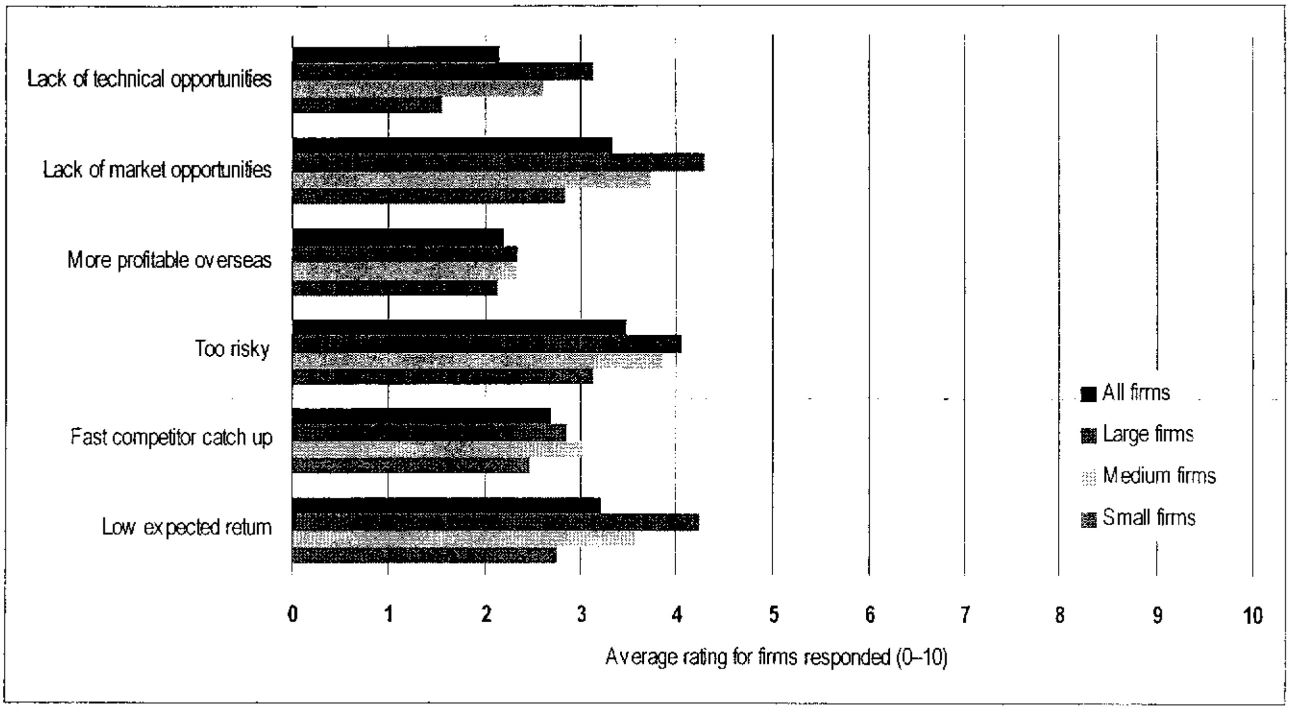
3.11 **R&D contracted out**



Data source: Survey results.

Of R&D being conducted, about 34 per cent is being contracted out by respondents (chart 3.11). About three-quarters of this is being conducted by other businesses. The remainder of the contracted out research is being done primarily by universities, CRCs, research centres and the CSIRO. Small and medium firms are marginally more inclined to make use of university research.

3.12 **Opportunity and motivation**



Data source: Survey results.

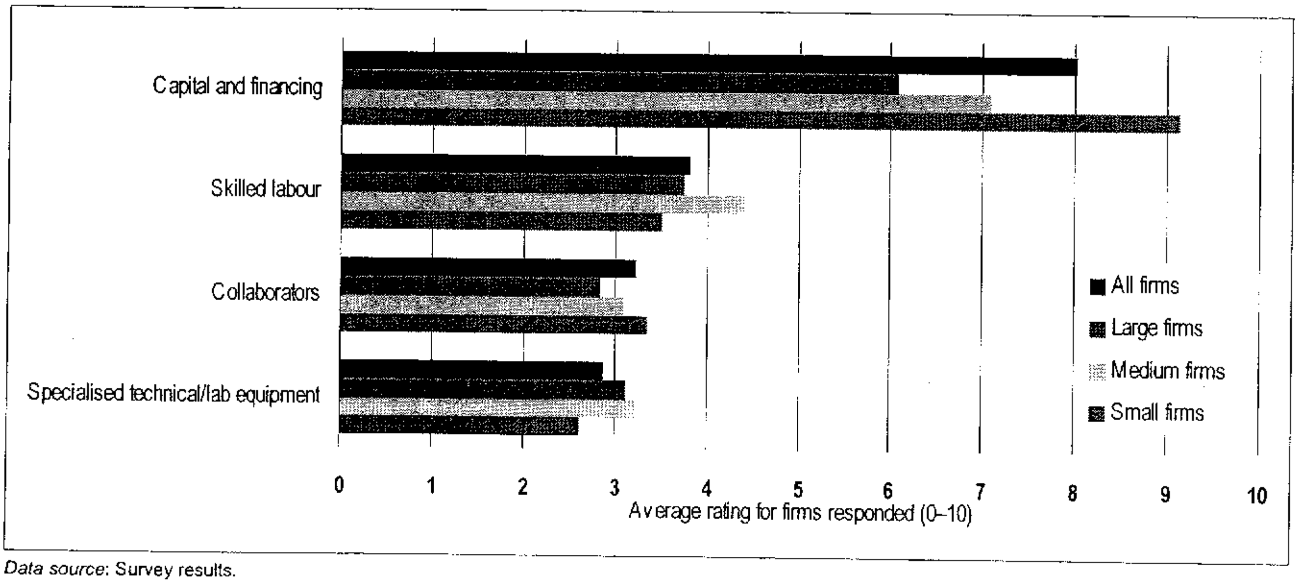
Constraints on R&D

As indicated in charts 3.12, 3.13 and 3.14, R&D does not appear to be tightly constrained except by capital. Most respondents indicated capital and financing to be the major constraint they faced in conducting R&D, followed by a lack of skilled labour and the company tax rate.

Opportunity constraints were considered marginally more important by larger firms, who indicated that a lack of technical and market opportunities were holding them back more than was the case for small and medium firms. In contrast, the capital and financing constraint was relatively more binding on small and medium firms. Small and medium firms also seemed marginally more concerned about the cost of patents and the inadequacy of intellectual property protection.

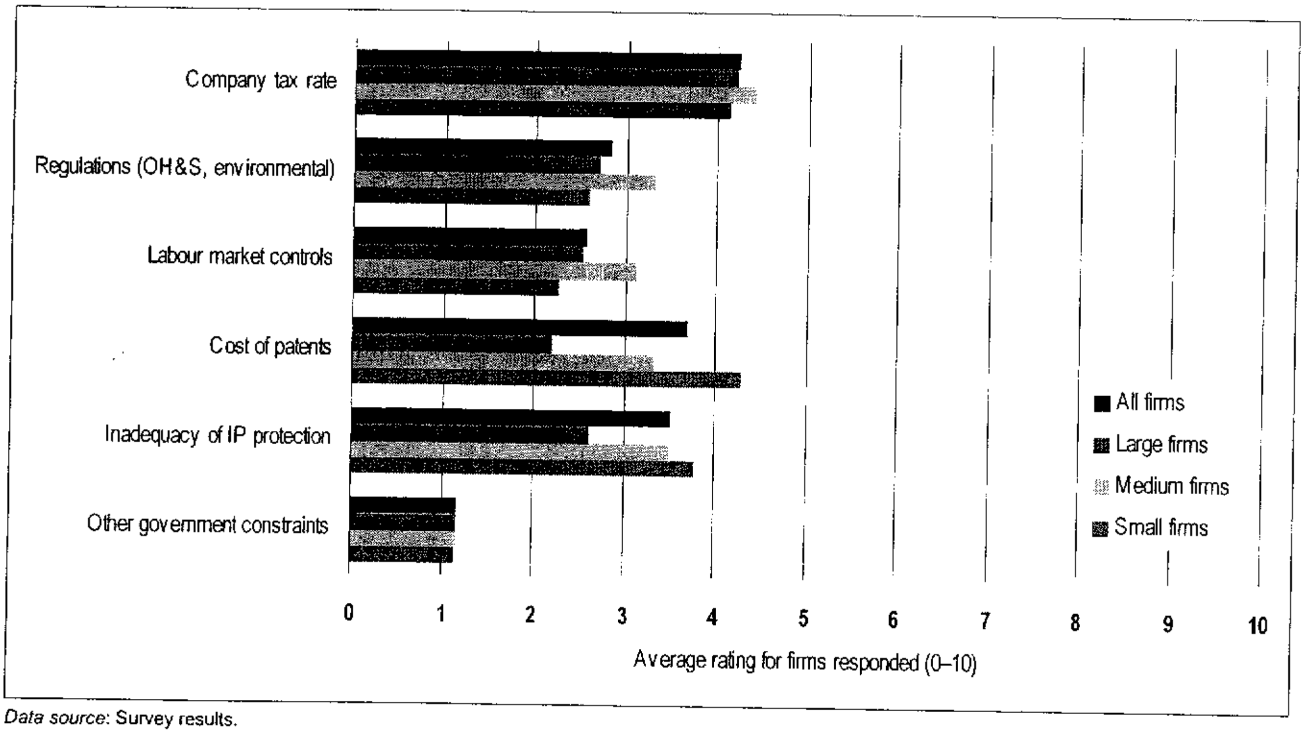
Only about 2.5 per cent of R&D appears to be conducted internationally by respondents (chart 3.15), with little difference between small, medium and large firms. The main reasons for going offshore for R&D appears to be skill availability and the need to be close to a client, while tax reasons seem to be a relatively minor factor (chart 3.16).

3.13 Resource availability



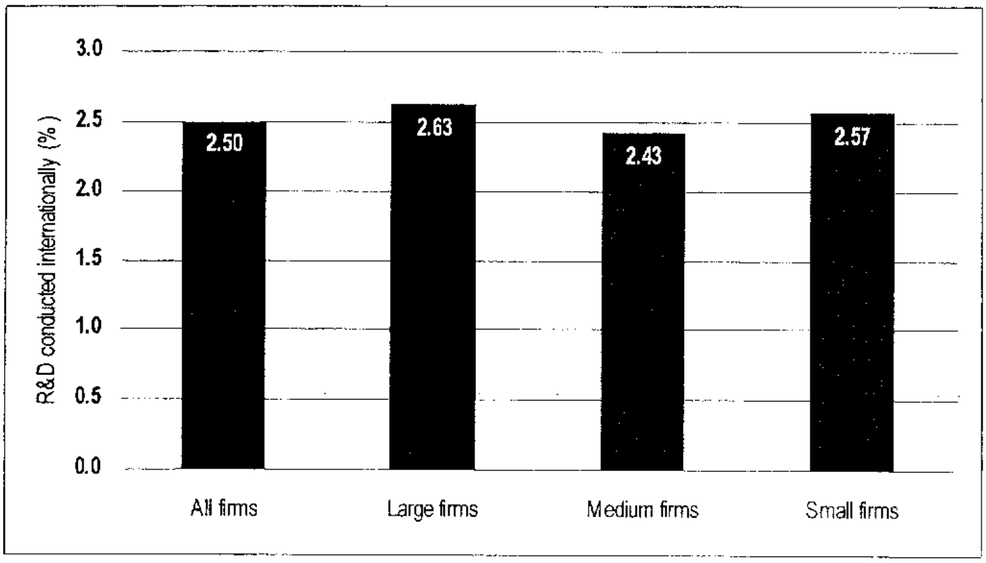
Data source: Survey results.

3.14 Government constraints



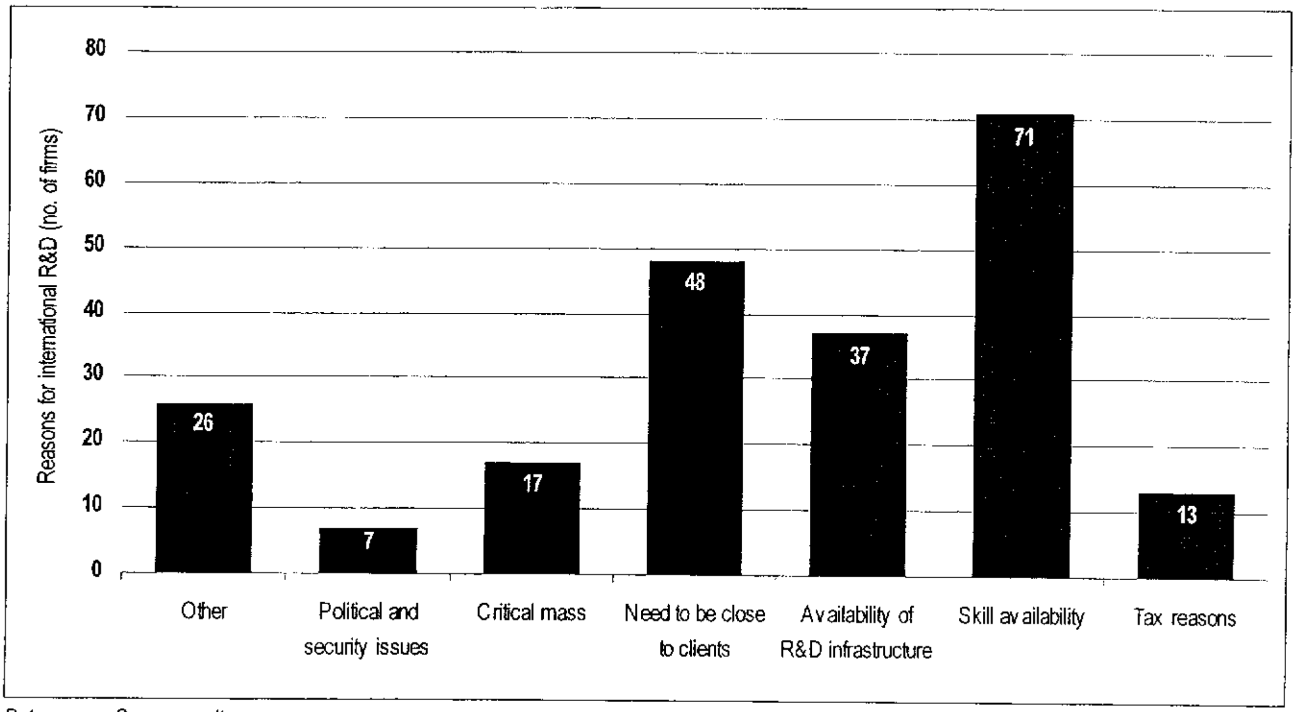
Data source: Survey results.

3.15 **R&D conducted internationally**



Data source: Survey results.

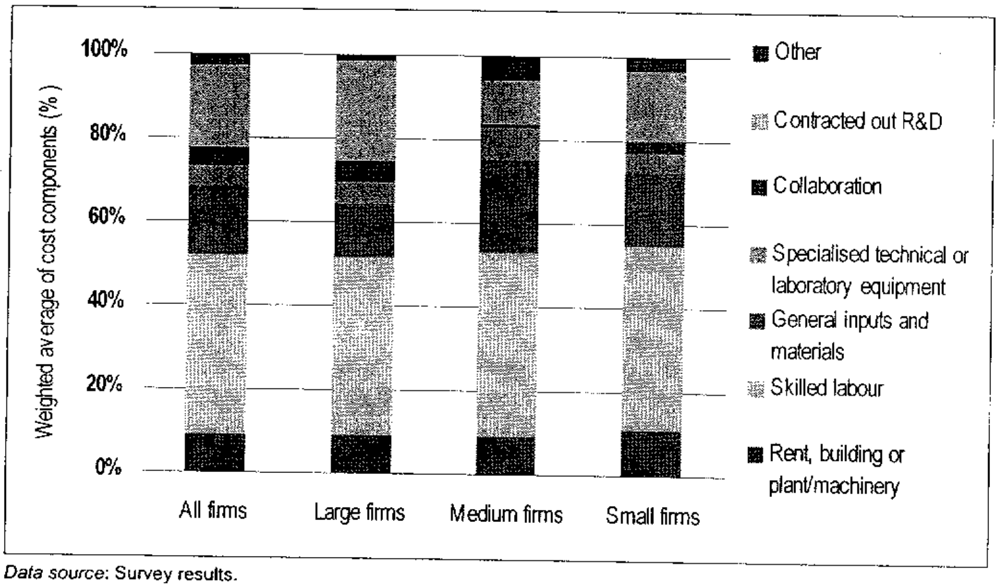
3.16 **Reasons for international R&D**



Data source: Survey results.

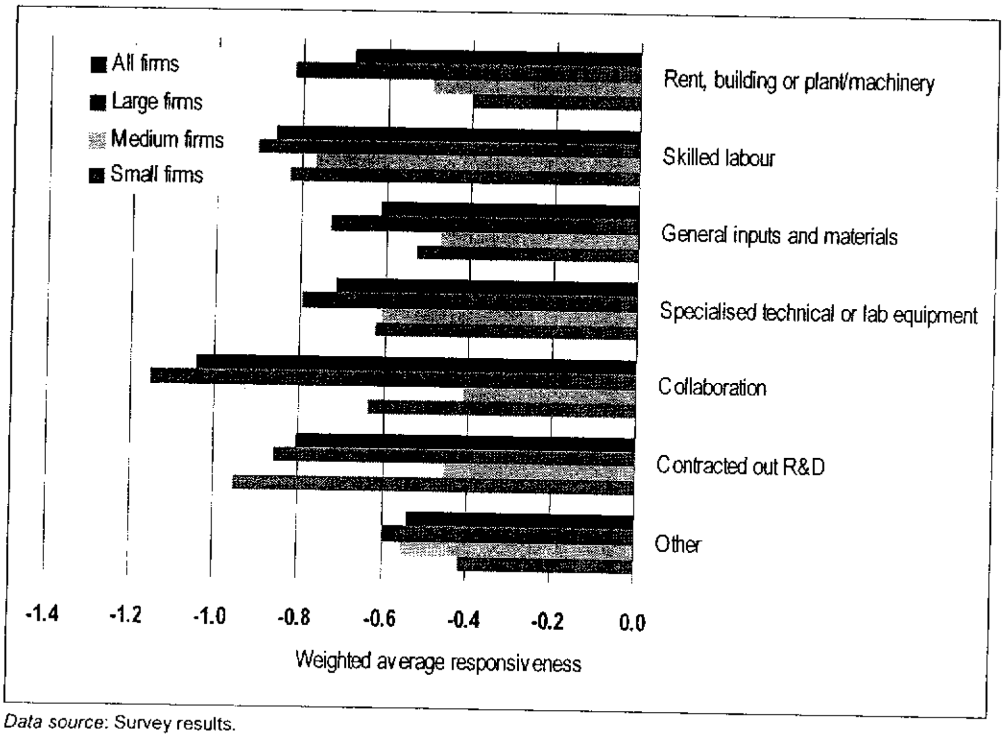
The primary cost driver for R&D expenditure is skilled labour, which makes up over 40 per cent of the total cost. Other important cost drivers include general inputs and materials and contracted out R&D. There is no significant difference between small, medium and large firms (chart 3.17).

3.17 **R&D cost structures**



Data source: Survey results.

3.18 **Responsiveness of R&D to increases in costs**



Data source: Survey results.

R&D responses to changes in costs

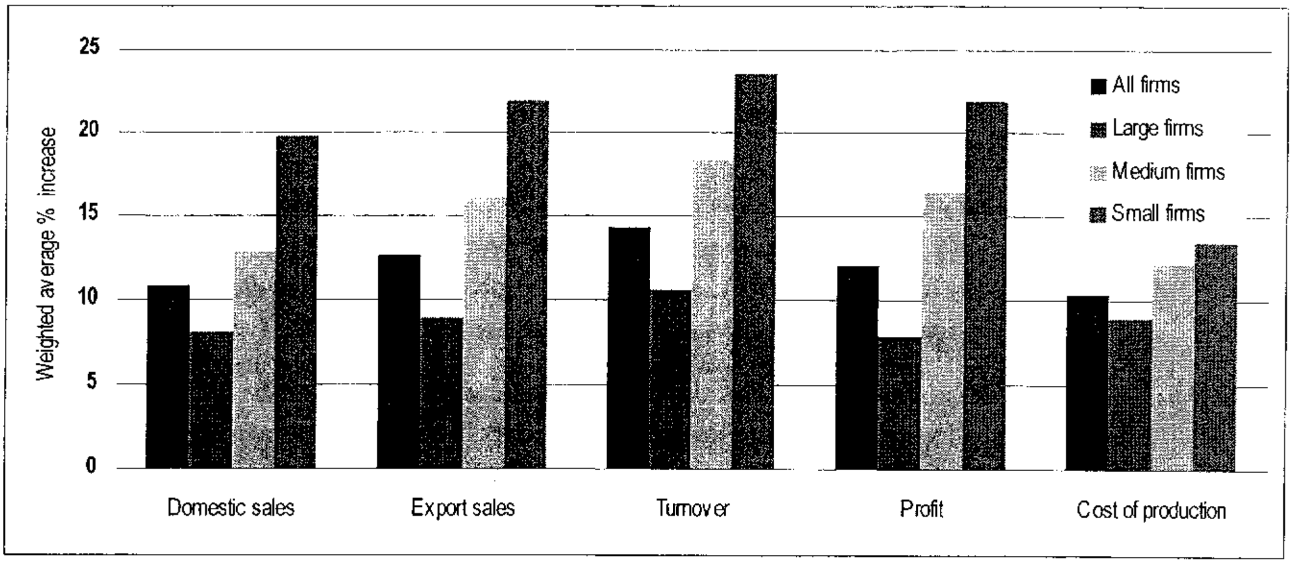
Chart 3.18 indicates that firms are relatively responsive to changes in the cost of their inputs, in the range of 0.4 to 0.8 per cent change in use for a 1 per cent change in costs. Responsiveness differed for different factors, with firms indicating a relatively higher level of responsiveness for a change in the cost of collaboration, skilled labour and contracted our R&D. In general, smaller firms indicated a slightly lower level of responsiveness to changes in the cost of inputs, indicating that they have less flexibility and fewer alternatives when it comes to cost changes. Alternatively, this may indicate that smaller firms take a more short-term perspective of their business decisions.

Returns from R&D

On average firms expect that a typical year's R&D will contribute substantially to sales and profits five years after it is conducted (chart 3.19). Smaller firms were considerably more optimistic than large firms. This trend was re-enforced by firms expected benefit-cost ratios from a successful R&D project (chart 3.20).

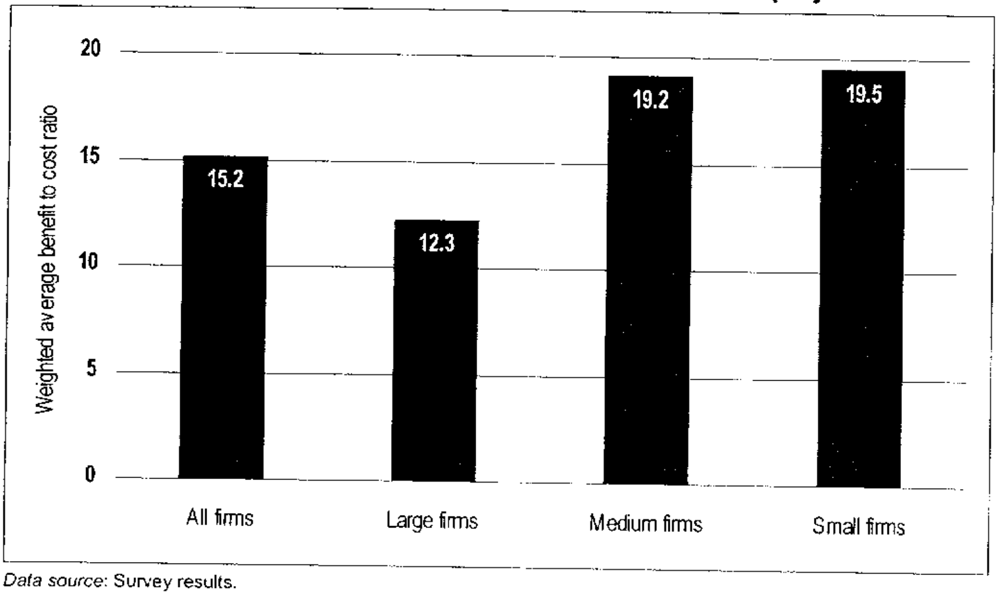
In general, firms expected a 73 per cent success rate in going from concept to prototype and that this will take them on average about 2.5 years. They expect about a 77 per cent rate of success taking a technically successful project through to the commercialisation stage and expect this to take an additional two years. They expect that the technical development stage will

3.19 **Effect of current R&D on future annual sales and profitability**



Data source: Survey results.

3.20 **Expected benefit to cost return from a successful R&D project**



Data source: Survey results.

cost about 30 per cent more than the commercialisation phase. On average they expect to retain their competitive edge for only about three years after commercialisation.

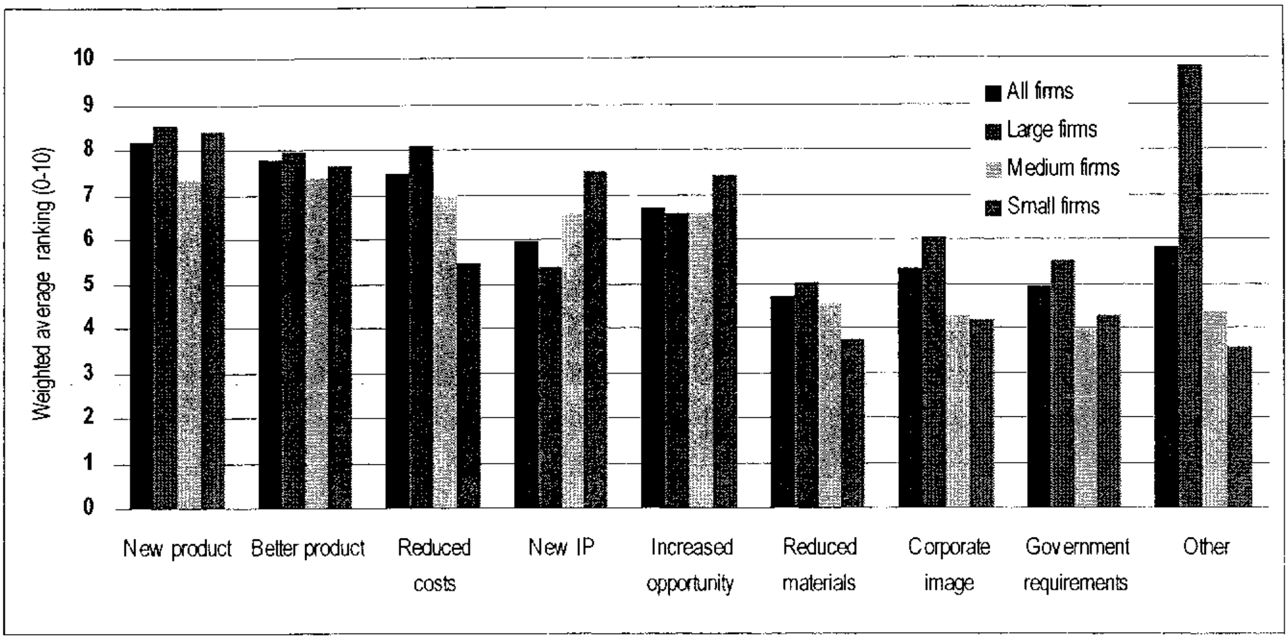
The main focus of R&D is on developing new and better products and reducing costs through process improvements. However, firms indicated that many motivations for R&D expenditure were important, including developing IP, creating increased opportunities, fulfilling government requirements and improving their corporate image (chart 3.21).

On average firms expect that about 50 per cent of their R&D is highly novel or develops a platform technology that might spur on innovations in other industries or applications. About 30 per cent of firms indicated that their R&D built on R&D developments in other industries and that these developments had been of moderate importance to them. The difference between these two numbers may indicate a tendency for firms to over-state their influence on others or to under-state the influence of others on themselves.

For those firms that took advantage of previous R&D developments, about a third obtained access to the R&D by buying the IP and a quarter were able to access it because it was not protected. Staff movement and reverse engineering were other sources of access.

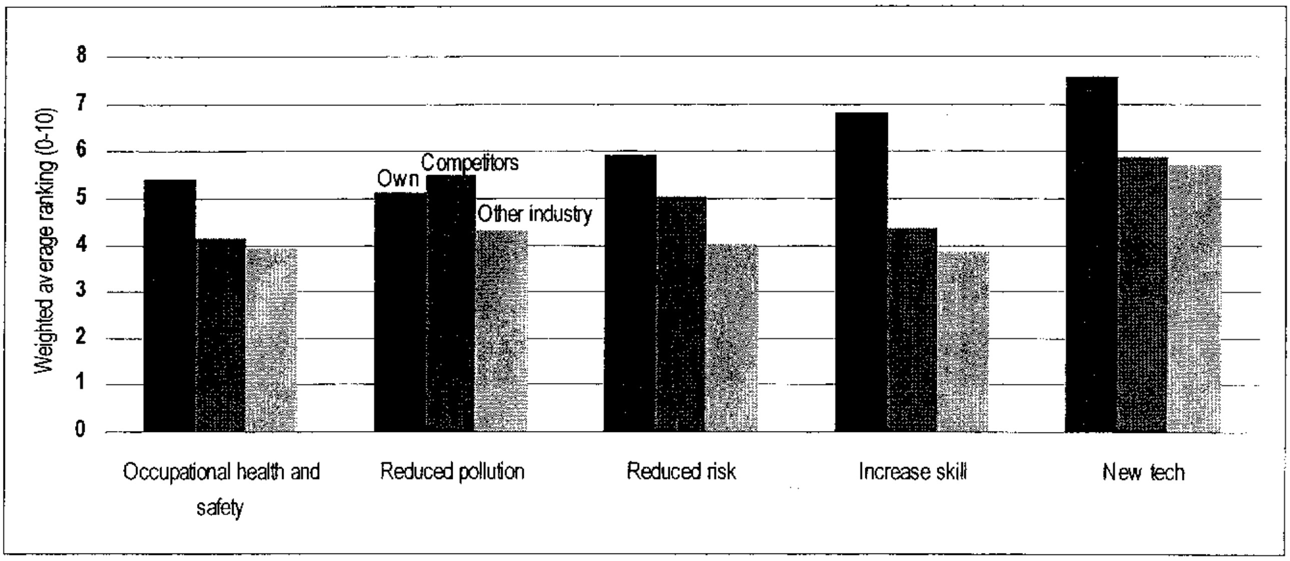
On average firms indicated expectations of moderate non-knowledge spillovers from their R&D for their own firms and lesser spillovers for their competitors and other firms (chart 3.22). On average firms expect that about 20 per cent of the benefit they will receive from their own R&D will come at the expense of their competitors.

3.21 **Relative importance of various R&D outcomes**



Data source: Survey results.

3.22 **Other spillovers: all firm average**

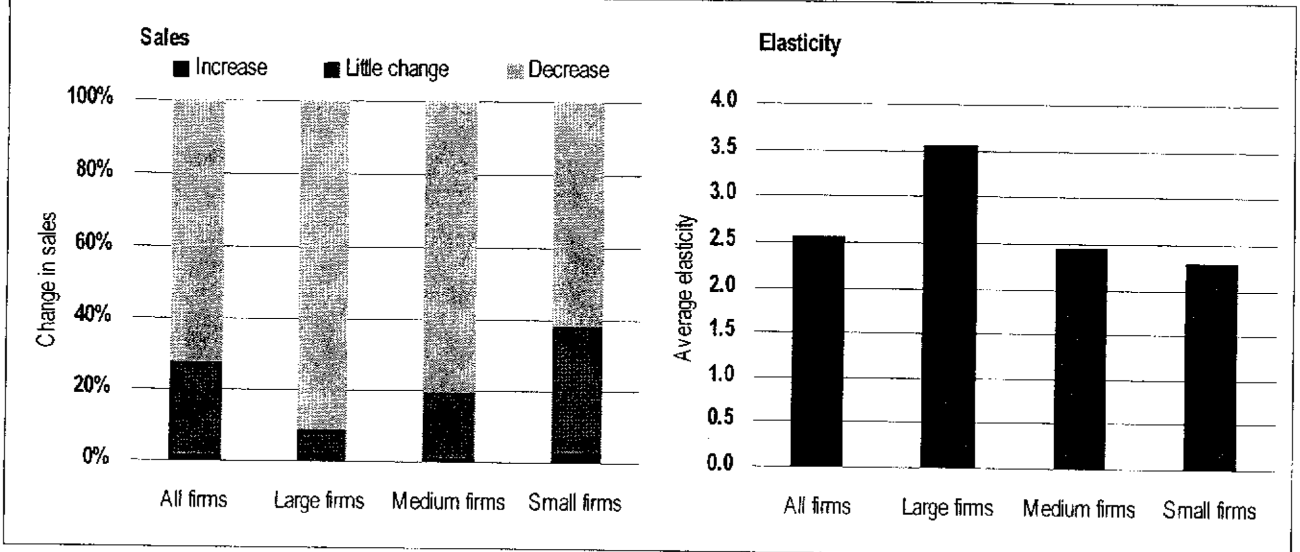


Data source: Survey results.

Demand conditions

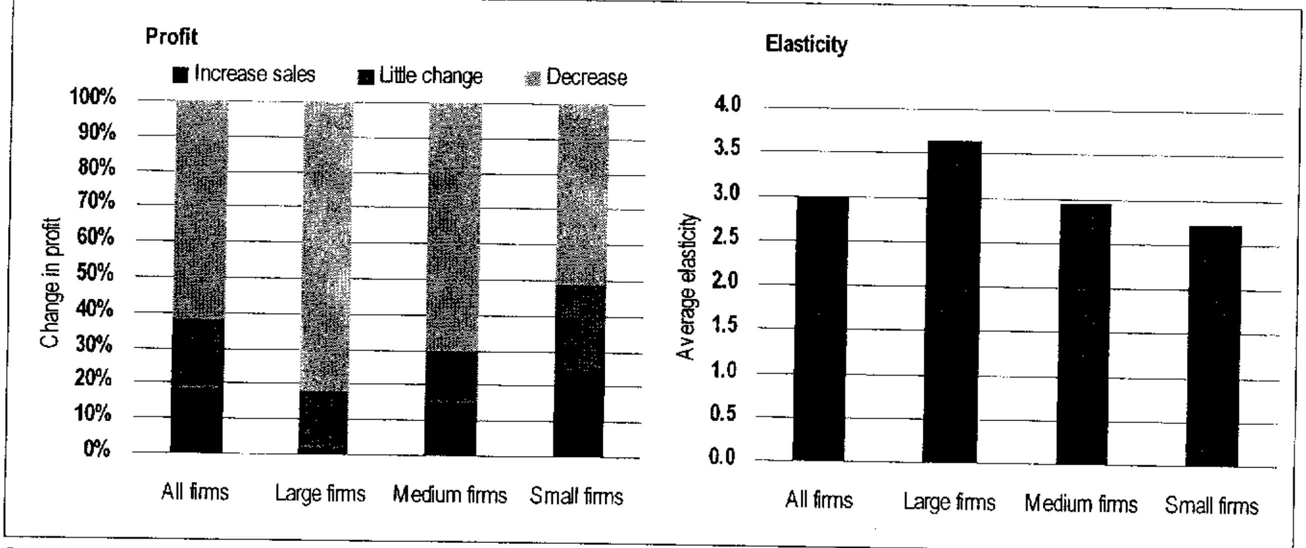
On average firms see themselves as price takers. A 10 per cent increase in their prices would see them reduce their sales 25 per cent (charts 3.23 and 3.24). Put another way, a 25 per cent increase in sales due to successful R&D could lower prices by 10 per cent.

3.23 **If you had to increase your prices by 10 per cent, what would it do to your quantity of sales?**



Data source: Survey results.

3.24 **If you had to increase your prices by 10 per cent, what would it do to your profit?**

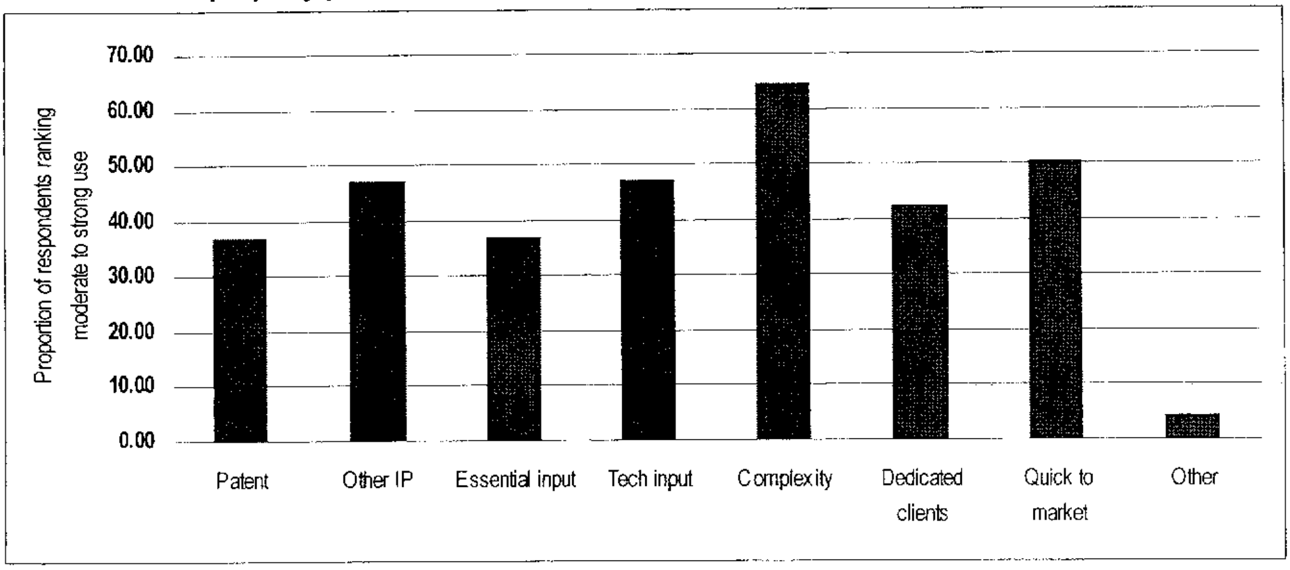


Data source: Survey results.

Intellectual property protection

Firms indicated high levels of protection against having their R&D copied. At least 37 per cent of firms indicated a moderate to strong reliance on each of eight categories of IP protection. About 65 per cent of firms indicated a moderate to strong reliance on the complexity of their production process to protect their IP (chart 3.25).

3.25 **Intellectual property protection**



Data source: Survey results.

4 *Costs of R&D Tax Concession program*

To be able to make a meaningful judgement on the net benefit of any government program it is necessary to have a detailed understanding of the costs involved in that program. These costs include more than the budget cost to the government.

With the R&D Tax Concession, in addition to the budget cost we must consider the administrative cost to the government and the compliance cost to the tax concession recipient. We must also consider the lost economic efficiency due to the tax that is necessary to fund this program. Finally, we should consider the cost of rent-seeking behaviour.

Budget cost

The cost of the R&D Tax Concession program is not known with total accuracy because the budgetary costs of the tax concession is experienced through tax forgone instead of monies paid. Estimates of the value of the tax concession are published by the government in the Tax Expenditure Statement (see box 4.1).

The 2002 TES estimates that the total cost of the R&D Tax Concession (including the 125 per cent R&D Tax Concession, the 175 per cent Premium Tax Concession and the R&D refundable Tax Offset for small companies) will be $412 million in 2003-04, rising to over $500 million by 2005-06. The 125 per cent tax concession is expected to cost $280 million in 2003-04, approximately two-thirds of the total cost.

While these numbers are only estimates, sensitivity analysis regarding the budget cost shows that the conclusions of this report are not sensitive to such estimates.

4.1 Tax expenditures and deadweight loss

The Government describes a tax expenditure as 'a tax concession that is designed to provide a benefit to a specified activity or class of taxpayer'. The Government produces a Tax Expenditure Statement each year. This document is the primary source for data on tax expenditures.

The cost of a tax expenditure is not direct, but rather is in the form of lost tax revenue. However, such programs still produce a deadweight loss because under the assumption of no other policy change, the existence of the tax expenditure requires taxes to be raised elsewhere to maintain the same budget balance.

Economic efficiency cost

All government programs need to be funded, even tax expenditures (forgone tax revenue — see box 4.1). This can be done either through current taxation, by printing money (which leads to inflation) or debt (which must then be paid for with future taxation). All of these options have costs in that they distort economic behaviour and hence economic efficiency.

Generally this economic efficiency cost — also referred to as deadweight loss or marginal excess burden of taxation — is calculated using the income tax as a standard tax. In reality, some taxes are more efficient and some are less efficient, but the income tax is useful as a guide to the efficiency cost of taxation.

Estimates for the efficiency cost of income tax vary in different studies and across countries. In a survey of various studies, Lattimore (1997) shows a range from 9 per cent cost (that is, $1 of tax raised creates an efficiency cost of 9 cents) to 303 per cent. Most estimates are between 20 per cent and 50 per cent, with the most recent Australian estimate being 19 per cent to 24 per cent (Campbell and Bond, 1997).

In the tax concession analysis by the BIE (1993) an estimate of 32.5 per cent was used. Lattimore (1997) used a slightly lower estimate of 27.5 per cent, with a range from 15 to 40 per cent. Based on previous studies, we use a range of efficiency costs, from 20 per cent to 40 per cent, with a mid-point of 30 per cent.

Administrative cost

Administration costs include the costs to the government of administering the tax concession program. The administration costs involved in raising the tax to pay for the program is included in the estimate of the efficiency cost of taxation.

It is not possible to determine an exact estimate for administrative costs as AusIndustry has only recently introduced time-based costing. In its review of the R&D Tax Concession, Allen Consulting Group (2000) used DITR advice to conclude that the total estimated cost of administering the R&D Tax Concession program for 1998-99 was $10.6 million. In addition, the cost to the ATO was $2.7 million in 1999-2000. Adjusted for 2003 dollars, the total administration costs would be approximately $15 million.

However, a more recent review from the Australian National Audit Office (2003) indicates that the total administrative cost (including the ATO) is only $10.2 million. This analysis uses the lower estimate of administrative costs.

Compliance cost

Compliance cost includes the costs to firms of complying with the rules and regulations of the tax concession scheme and, where appropriate, of employing tax consultants to apply for the concession.

The BIE (1993) suggested a compliance cost of between 1.6 and 3 per cent of eligible R&D. Lattimore (1997) argued that such estimates are inappropriately high and that 0.5 per cent is more appropriate. However, in their survey of tax concession recipients, ACG (2000) reported compliance costs at 3.4 per cent of R&D expenditure.

From our survey results we found that the average compliance cost per year was about $22 000. The burden of compliance costs as a share of total R&D spending was relatively higher for small firms (2.2 per cent of total R&D spending) compared with large firms (0.8 per cent of total R&D spending). In all, the weighted average compliance cost of the tax concession of just over 1.0 per cent of total R&D spending, and this is the number we have used in this analysis. According to the AusIndustry database, the value of R&D supported by the tax concession is just over $5.7 billion, which gives a total compliance cost of around $60 million.

However, this value represents the total compliance cost for all aspects of the tax concession scheme (including the 175 per cent Premium Tax

Concession and the R&D Tax Offset). While the 125 per cent R&D Tax Concession makes up about two-thirds of the cost of the tax concession, we have attributed slightly less than two-thirds of the compliance cost to the 125 per cent tax concession. This is because the 175 per cent Premium Tax Concession and the R&D Tax Offset are relatively new and may temporarily be taking up a disproportionate amount of compliance costs. For this analysis, we have attributed $35 million of compliance costs to the 125 per cent R&D Tax Concession.

Rent-seeking cost

Whenever the government intervenes in an area of the economy it creates a political cost. Market participants now must consider government policy in their decision framework and changes to government policies can be potentially highly profitable. In recognising the value of various government policies, market participants will spend resources trying to influence the government. This lobbying behaviour is referred to as rent-seeking.

While rent-seeking undoubtedly occurs in every area of government intervention, the costs of such behaviour are hard to quantify. Subsequently, for the purpose of this review we will assume such costs to be zero. While the existence of rent-seeking costs would make the total cost of the tax concession program higher, it is unlikely that the costs would be significant enough to alter the conclusions of this report.

4.2 **Cost of the 125 per cent R&D Tax Concession 2003-04**

Cost type	*Cost*
	$m
Budget cost (for financial year 2003-04)	280
Efficiency cost	85
Administrative cost	10
Compliance cost	35
Rent seeking cost	([a])
Total cost	**410**

[a] Unable to determine an accurate cost.

Source: CIE calculations and Commonwealth of Australia (2003).

Total cost of the R&D Tax Concession

From the above analysis, we are now able to estimate the total annual cost of the R&D Tax Concession.

The total cost of $410 million is made up of a budget cost of $280 million, as well as an additional $130 million worth of additional costs (efficiency, administrative and compliance costs). These additional costs represent a 46 per cent mark-up over the fiscal cost.

It should be noted that the budget cost of $280 million represents a transfer of funds from taxpayers to researchers. To the degree that researchers appropriate the funds without changing their R&D behaviour, this is a direct funds transfer and the cost to the government will be matched by the benefit to the recipient. Excluding considerations of alternative marginal values to money — such transfers produce a zero net benefit. In the instances where researchers choose to alter their R&D behaviour, it is reasonable to assume that they will at least regain the cost of their investments back in private benefits.

It is possible at this point to consider a 'back of the envelope' approach to determining the effectiveness of the R&D Tax Concession. If we make the simplifying assumption that the fiscal costs of the tax concession program are roughly matched by the market mediated benefits derived from the R&D then we are able to simplify the entire analysis down to a comparison between the additional costs and the induced spillover benefits.

As the additional costs are equal to $130 million the program requires induced spillovers of $130 million to break-even. Given that induced spillovers are determined as: inducement rate * spillover rate * budget cost, we are able to predict that that the R&D Tax Concession scheme will break even if the product of the inducement rate and the spillover rate is higher than 46 per cent. For example, this would be true if the inducement rate was 70 per cent and the spillover rate was 66 per cent[2]. The following chapter will consider the inducement rate and the spillover rate in more detail.

[2] This is only a rough guide and excludes important additional information which will be discussed in the following chapters.

5 *Benefits of the R&D Tax Concession*

In this chapter we will try to determine how effective the R&D Tax Concession is at producing national benefits. The first step in this analysis is to determine how much more R&D is being done because of the tax concession — we call this the *inducement*. The second step is to calculate the R&D benefits that flow from the induced R&D. These benefits will be private, flow-on and spillover. While this report offers new information regarding the inducement rate and private benefits, it does not provide a new estimate of spillover benefits and instead relies on previous research.

Induced R&D

The rate of inducement has been identified as one of the most important parameters in determining the benefit of the R&D Tax Concession scheme. In this report, inducement refers the amount of extra money spent on R&D as a percentage of the financial incentive provided by the government to companies. That is, if the government forgoes $100 of tax revenue to a firm, and the firm spends an additional $50 on R&D, then there has been a 50 per cent level of inducement.

The financial incentive provided by the R&D Tax Concession is dependent on the level of the tax concession and the level of the company tax rate. Currently, with a 125 per cent tax concession and a company tax rate of 30 per cent, the R&D financial incentive is roughly equal to 7.5 per cent of R&D costs. When the tax concession was introduced it was at 150 per cent and the company tax rate was at 46 per cent, so the R&D financial incentive was equal to 23 per cent. Since then, the reduction in the level of the tax concession and reductions to the company tax rate have reduced the relative size of the financial incentive.[3]

[3] The issue of the effective financial incentive from the tax concession program was discussed in more detail in chapter 1.

In 1997 Lattimore calculated that the 125 per cent R&D Tax Concession (with a financial incentive of 9 per cent) would encourage an additional 8.6 per cent expenditure in R&D. This is equivalent to a 95 per cent level of inducement. Other international reports have suggested inducement rates of anywhere between 'insignificant' (Eisner et al., 1982) and 200 per cent (Hines, 1990). Most studies suggest a number between 30 per cent and 130 per cent.

In 2000, before the latest changes to Australia's tax concession program, an international econometric study of inducement rates by Bloom, Griffith and Van Reenen reported an average inducement rate of nearly 100 per cent. When adjusted to include the user cost of physical capital as an additional variable the inducement rate is estimated to be 77 per cent. Under various alternative assumptions the authors find slightly lower inducement rates, but they conclude that their model is relatively robust. Country specific adjustments indicate that the inducement rate from the Australian tax concession (as it existed at the time) may have been lower than average[4].

For this analysis we will use both a survey-based approach (as previous studies have done) and an analytical approach to derive our estimated inducement rate. The use of an analytical approach should give us more confidence about the level of the inducement rate than would exist if we were to base our estimate only on direct survey answers.

It should be noted that all methodologies utilise data derived from survey answers, and thereby include a degree of subjectivity. In addition, the quality and objectivity of survey answers may depend on the status of the respondent (that is, whether the respondent is the R&D Manager or the Chief Financial Officer etc). Thus, while we have no reason to believe such differences will lead to any systematic bias in the results, we cannot rule out the possibility.

We have compiled six different methods of deriving inducement, with various levels of complexity. The first four methods are based directly on survey answers. These include a direct question about responses to a change in the tax concession, a question about historical changes in response to previous reforms, a question about a hypothetical change in

[4] The study indicated that the average inducement rate increased when Australia was excluded from the group – indicating that Australia's inducement rate was lower than average. The study did not identify any reasons for differences in inducement rates between countries. It should be noted that the report was written in 2000, before the most recent reforms to the Australian tax concession scheme.

incentives and a question about the number of activities influenced by the tax concession.

The final two methods utilise an analytical framework. The 'simple model' uses limited survey information and derives an elasticity of R&D demand. The 'complex R&D model' incorporates various additional pieces of information from the survey such as demand elasticities of final products and non-linear supply elasticities for R&D inputs. The methodology used in our economic R&D model is outlined in Table 5.2 below and further in appendix B.

Table 5.1 outlines the different inducement rates calculated using the different methodologies. In addition, we have split the data into three categories, for high R&D firms (more than $1 million R&D expenditure), medium R&D firms (between $500,000 and $1 million) and small R&D firms (less than $500,000)[5]. Below is a brief discussion of each methodology.

5.1 Estimated inducement rates

Methodology	*Estimated inducement — average*	*Estimated inducement — high R&D*	*Estimated inducement — medium R&D*	*Estimated inducement — small R&D*
	%	%	%	%
Direct method	206	162	226	243
Historical method	91	91	92	81
Changed incentive method	57	54	79	76
Projects method	*	*	*	*
Simple model (c)	67	68	56	59
Economic R&D model	69	71	55	62

* Specific estimate not available

Source: CIE calculations.

Survey-based results

Direct question

The direct question in the survey indicated an inducement level of about 200 per cent. There are several reasons for believing that this is probably an over-estimate of the inducement level.

The first concern with such a question is that it invites a strategic answer, where survey respondents may exaggerate their benefits. Also, it may be

[5] Note that this classification of small, medium and large is different from the classification as provided in Chapter 3. In chapter 3 the classification was with regards to firm size (as measured by employees), while in this chapter we are referring to the amount of R&D expenditure, irrespective of firm size.

true that the very act of filling out the survey increases awareness of the benefits of the R&D Tax Concession, but by the time corporate decisions are made about R&D investments other considerations are seen as more important.

When the R&D Tax Concession was reduced from 150 per cent to 125 per cent, a survey was conducted by Price Waterhouse and the Australian Industrial Research Group (PW-AIRG, 1996). Lattimore interprets their survey to show an expected inducement level of 170 to 180 per cent, which he suggests is 'implausibly high'. Indeed, as later analysis has shown (including the section immediately below), the impact of the change was significantly less important that expected in the PW-AIRG survey.

In addition to these concerns, the nature of the survey question on which it is based may lend itself to misinterpretation. The survey question (question 2.5) asks how much additional R&D a firm would undertake if the R&D Tax Concession were increased by 25 per cent. The average answer was 15 per cent. It is unclear whether respondents were attempting to indicate a 60 per cent inducement (15/25) or a 200 per cent inducement (15/7.5), as some respondents may not have calculated that a 25 per cent increase in the tax concession is equal to a further 7.5 per cent reduction in costs.

Historical method

The historical method indicated an inducement level of about 90 per cent. It is informative to compare this result with the predictions of the PW-AIRG (1996) survey results, which predicted an inducement level of around 170 to 180 per cent. This indicates that firms may be inclined to report higher levels of responsiveness to the tax concession than is actually the case.

This method relied on answers provided to question 2.4 regarding changes in behaviour following the 1996 reforms to the R&D Tax Concession scheme. The historical method has fewer potential problems than the direct method, however this approach is still potentially vulnerable to strategic answering.

Changed incentive method

This method indicated an inducement level of about 60 per cent. The changed incentive method asked R&D Tax Concession claimants how much more R&D their firm would do if their threshold required rate of return was lowered by 20 per cent (question 2.6). This is equivalent to a reduction of R&D costs by 20 per cent.

By asking a more indirect question, the approach is potentially less vulnerable to strategic answering. However, the hypothetical circumstance proposed in this approach may not be realistic for many firms, especially smaller firms with more discrete R&D investment opportunities. Because of this, the authors consider this approach to be less robust than the historical or analytical methods used and would not recommend the future use of this method.

Induced projects method

R&D Tax Concession participants were asked what consideration they gave to the tax concession when making their R&D project decisions. 45 per cent of firms indicated that they gave no consideration to the tax concession, while 42 per cent indicated that they gave some consideration to the tax concession, but it didn't change their investment decisions. Only 12 per cent of firms indicated that they undertook a research program because of the tax concession and these firms made up 10 per cent of R&D. This result is similar to the results found in the DITR/Allens report, which indicated that 11.8 per cent of total R&D expenditure was influenced by the tax concession.

This methodology does not give a point estimate of inducement because there is no information on how much of the 10 per cent would have gone ahead without the R&D Tax Concession. If we assume that none of that R&D would have gone ahead without the tax concession then we can derive an extreme upper bound for inducement. Given an incentive effect of 7.5 per cent, the additional 10 per cent of R&D investment would represent an inducement rate of around 140 per cent.

It is highly unlikely that all investors influenced by the R&D Tax Concession would stop all of their investment without the concession. If we assume that the tax concession caused them to double the amount of R&D they pursued, then the inducement rate would be about 70 per cent. However, without further information it is not possible to provide a clear point estimate.

Analytical approaches

Simple model method

The simple model takes into consideration various stated demand elasticities for R&D inputs as well as various constraints on R&D input supply. With the moderate assumption of binding resource constraints but no opportunity constraints, the simple model predicts an inducement rate of 67 per cent.

Limited sensitivity analysis was undertaken, altering the assumptions regarding R&D constraints. Taking into account reported constraints on R&D opportunities, the estimated inducement falls to 48 per cent, and with no constraints at all the inducement rises to 80 per cent.

Economic R&D model

The methodology behind the economic R&D model is outlined in box 5.2. The model gives an estimated inducement of 69 per cent. The response from this model is the one considered most robust. The results from this model have been subject to various sensitivity tests, which confirm a likely range of inducement rates of 50 to 90 per cent. These tests include modifying the assumptions regarding various substitution elasticities and methods of interpreting survey data.

The primary reason for the sensitivity tests was to test the assumption of timing. While the relevant survey questions do not specify whether answers should be short-term or long-term, the model assumes the answers are long-term. The nature of the questions are such that most firms are likely to provide long-term answers, however this may be less true for firms that have smaller R&D budgets, who are less likely to have long-term R&D plans.

The estimated inducement rate was lower for firms that did less R&D, at 62 per cent for small R&D firms and 55 per cent for medium R&D firms. This is consistent with the theory that firms with small R&D budgets will tend to take a shorter time horizon and hence will underestimate their inducement. However, even if we exclude all firms that do less than $1 million R&D annually (regardless of size) the inducement rate would not change significantly – rising to 71 per cent. This is because firms with a significant R&D budget make up such a large proportion of total R&D done. In addition, a wide ranging sensitivity test regarding the responses of firms with relatively low investments in R&D indicates that even the most optimistic or pessimistic of adjustments does not move the estimated inducement outside of the 50 to 90 per cent range.

5.2 Methodology behind our Economic R&D Model

Central to this report is our estimation of the additional R&D done by companies in response to the tax concession. One important tool in our estimation of inducement is our economic model of R&D.

How much more R&D a company will conduct due to the tax concession will depend on three important conditions: the share of R&D costs in total costs; the availability and cost of extra R&D resources; and the contribution that extra R&D is expected to make to future profits.

- The share of R&D costs in total costs is important because:
  - the higher the share, generally the greater the potential absolute increase in R&D;
  - the smaller the share, generally the greater the potential relative percentage increase in R&D;
- The availability of extra R&D resources and how their costs might change as the company conducts more R&D is important because:
  - in some cases, where critical equipment, highly specialised labour or more technological ideas are required, it may be difficult and expensive to acquire more R&D resources, or to substitute other R&D resources to overcome various R&D constraints;
  - in other cases, there may be plenty of new ideas to research and skilled labour and required equipment is readily available, making expansion relatively easy without an increase in unit costs of conducting R&D;
  - reduced costs may also encourage firms to substitute away from non-R&D resources toward more R&D resources;
- The increased contributions that extra R&D could add to future profits is of obvious importance, although:
  - in some cases the firm may also be motivated by improving its corporate image or meeting government regulatory targets, but ultimately this has a bearing on increasing profits of the firm;
  - in some cases firms may have totally philanthropic objectives for conducting R&D, but these are unlikely to be highly sensitive to small reductions in the costs of conducting that R&D.

Lowering the cost of one type of input — R&D — has the potential to cause a firm to alter its entire mix of inputs in favour of R&D, and to expand its overall use of inputs so as to expand output. Based on the information collected in the survey, we can model how much each firm is likely to expand R&D given the conditions above. We do this by modelling the profit maximising and cost minimisation behaviour of the firm. In essence, from the survey data we calculate what economic incentives firms face to change their R&D as a result of the tax concession.

- Generally, when a firm invests in R&D it seeks to maximise the contribution of R&D to the firm's profits. To do this, it must optimise its use of inputs and, as part of that, minimise the costs of conducting its optimal level of R&D.

(Continued)

5.2 Methodology behind our Economic R&D Model (continued)

- The firm will seek to maximise profits by optimising its mix of inputs: labour, capital, purchased materials and R&D.
  - The optimum will depend on the contribution each input makes to profit and the relative cost of each input.
  - Determining this optimum will implicitly determine the derived demand for R&D.
  - A change in the cost of R&D to the firm due to a tax concession will alter the optimal mix of inputs and therefore alter the derived demand for R&D.
  - How the derived demand for R&D changes will be one factor determining how much extra R&D is induced by the tax concession.
- Given the derived demand for R&D determined above, the firm will seek to minimise the cost of conducting R&D.
  - This will determine an optimal mix of R&D inputs such as highly skilled labour, specialised equipment, collaboration, patents, other plant and equipment and other labour.
  - This optimum will in turn determine the derived demand for each component of R&D.
  - An increase in derived demand for R&D will cause a change in the mix of R&D inputs used depending on the relative productivity of each.
  - A change in the cost of some components of R&D and not others due to the tax concession, will also alter the optimal mix of R&D inputs, and therefore alter the derived demand for each of these.
  - How the derived demand for each R&D component changes will be another factor determining how much extra R&D is induced by the R&D tax concession.

Survey responses provide considerable information about each firm's optimisation and minimisation choices and the three important conditions affecting them. By modelling these choices and conditions in a consistent quantitative framework, we can determine the influence of the tax concession on each firm within reasonable bounds of accuracy.

In addition to such data sensitivity analysis, the model's assumptions were adjusted to imitate a hypothetical long-run scenario[6]. Under various long-run assumptions the inducement was estimated to be 40 to 80 per cent. These sensitivity tests re-enforce the robustness of the model and allow greater confidence in the conclusions. Another consideration with the R&D model is that it assumes a constant elasticity of demand for R&D and it does not consider economy-wide constraints. Depending on the nature of the real demand for R&D the first assumption could bias the results in

[6] All constraints on R&D inputs were assumed to be non-binding, except for skilled labour which must be binding in the long term.

either direction, while the latter assumption will result in an overestimate of R&D[7].

Finally, if we classify firms by turnover instead of by their amount of R&D investment this makes no significant difference. Further details on this issue are available in Appendix D.

Conclusion

Both the economic R&D model and the simple model indicated that the inducement rate was around 70 per cent (69 and 67 per cent respectively) with sensitivity analysis indicating a range from 50 to 90 per cent. In addition, the historical approach suggested an inducement rate of 91 per cent. Based on the above estimated inducement rates we prefer a range from 50 per cent to 90 per cent, with a mid-point of 70 per cent. This range is broadly consistent with the conclusions of previous studies.

It should be noted that, while the above approach to estimating inducement is relatively robust when compared to previous approaches, it is not possible to draw definitive conclusions about the level of inducement. For instance, it is generally believed that R&D investment and investor confidence are positively correlated with the business cycle. Subsequently, as the present survey was conducted during a climate of strong economic growth the survey answers may tend to be optimistic.

Additional private benefits

From the above discussion of inducement we are able to conclude that, of the fiscal cost of the R&D Tax Concession scheme, about 70 per cent will go towards R&D activities and 30 per cent will be a transfer between the government and the firm. It should be noted that the transfer element is not a net social cost, because the fiscal cost of the funds is matched by the benefit gained by the firm. However, such a transfer is also not a net social gain.

[7] Economy-wide constraints would result in a decreasing marginal inducement from the government incentive. This effect has been shown in previous studies such as Lattimore (1997) and the BIE report (1993).

Private rate of return from R&D

Many studies have attempted to estimate the private rate of return coming from R&D. Most of these estimates are in the range of 20 to 50 per cent. For this report we are able to determine a private rate of return from the survey responses.

Firms reported a weighted average non-discounted benefit-cost ratio of 7:1, which indicates a net benefit of 600 per cent over an initial investment. Using a 20 year time horizon (which was explicit in the survey question) we conclude that the simple private rate of return on R&D investments is about 35 per cent. This estimate is consistent with previous studies.

Based on survey responses we are able to estimate a time profile for R&D investments, and using a 10 per cent discount rate over 20 years we are able to determine a present value benefit-cost ratio. This was calculated to be 3.4 to 1.

However, there may be some reason to think that this result is biased upwards. Typically, managers of R&D projects are optimistic about their probabilities of technical, commercialisation and market development success. In addition, firms who value R&D more highly may be more likely to participate in surveys regarding R&D. Finally, to the degree that survey respondents were answering strategically, there may be an incentive for R&D managers to overstate their expected benefits. For these reasons we might expect our results to represent an optimistic estimate of average private returns.

Private benefits from induced R&D

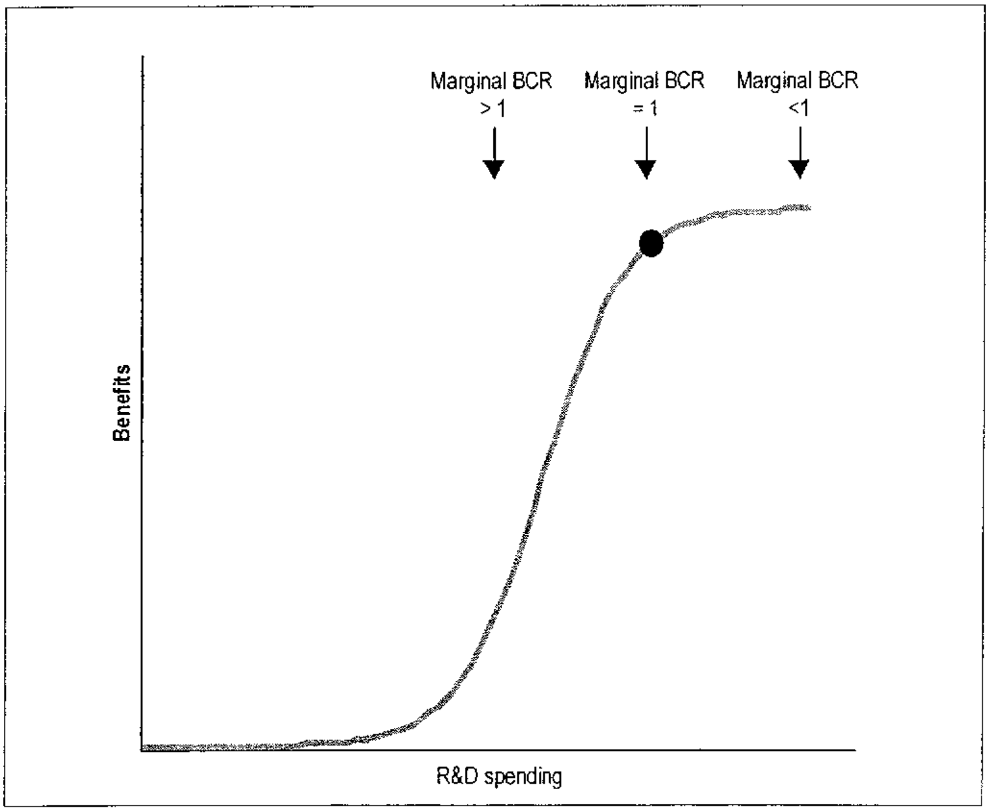
The above results represent average results from R&D investments and do not represent the likely benefit from an additional dollar invested in R&D. As with all investments, it is likely that firms prefer R&D projects with high returns and such projects are the first approved. The last R&D projects approved could be expected to have returns slightly above or near 1:1 while those R&D projects rejected might be expected to have returns below or near 1:1 (chart 5.3).

The implication of this is that the private benefit of the R&D Tax Concession is equal to the fiscal cost of the program – which is $280 million. Of this spending, 30 per cent ($84 million) is transferred from the government to firms with a benefit-cost ratio of 1:1 and 70 per cent ($196 million) is invested in marginal R&D projects with a private benefit-cost ratio of approximately 1:1.

However, not all of this benefit goes to Australian citizens. Some proportion of total private benefits will be attributable to foreigners, with the amount dependent on amount of foreign ownership, adjusted for withholding taxes and other aspects of the treatment of repatriated dividends. Lattimore assumes that the foreign leakage is about 20 per cent so that the private Australian benefits is equal to 80 per cent of the total private benefit.

From our survey about 30 per cent of R&D firms (weighted by the R&D intensity) were foreign owned. If we make the assumption that 33 per cent of foreign profits accrue to Australia (through taxes and other transfers) then we are left with a leakage estimate of 20 per cent. In other words, similar to Lattimore, we estimate that the private Australian benefit is equal to 80 per cent of the total private benefit.

5.3 **Decreasing the marginal return to R&D investment**



If this is the case, then the total Australian private benefit from the R&D Tax Concession is equal to 80 per cent of the total fiscal cost of the program. That is, 0.8 * $280 million, which is equal to about $224 million. It should be noted that foreign R&D does provide a benefit to Australia, both through taxes and other transfers (as above) and also through flow-ons and spillover benefits (discussed below).

An alternative interpretation

Sometimes it is argued that the marginal return on R&D investment is higher than 1:1 and higher than the marginal return on non-R&D investments. In support of this proposition are the high private benefits from R&D, especially when compared with the private benefits that could be expected from capital investment. Our survey recorded a private return on R&D of about 35 per cent, which is similar to typical estimates of between 20 and 50 per cent. In contrast, most estimates of private returns on capital investments vary between 10 and 30 per cent.

Based on these figures and the arguments outlined at the end of chapter 2 (under alternative rationales for government intervention), some commentators, such as Dowrick (2002), argue that the marginal private returns on R&D investment are higher than the marginal private returns on capital, and are therefore capable of producing a benefit–cost ratio of greater than 1:1. If this is the case, then the induced R&D from the tax concession program would produce benefits greater than the fiscal cost of the program (that is, greater than $280 million). Indeed, Lattimore notes that this perception was probably quite influential when the R&D Tax Concession was introduced and it still is implicit in some of the objectives of the tax concession scheme.

However, there is little current evidence to support this position, and several factors that militate against it:

- The most common explanation for the difference in rates of return is that R&D investment is more risky than capital investment. Economic decisions are made on the basis of expected returns (potential returns * probability of success), and as R&D investment has a higher risk it is necessary for it to have a higher return to make it an equivalent investment.
- Studies of private returns to R&D and capital investments consider the average benefit, not the marginal benefit. Even if marginal private returns were roughly equal (at about 1:1) there would be no reason to expect average private returns to be equal because capital and R&D investments could have different rates of decreasing marginal benefit.

Subsequently, the difference in average rates of return provides no evidence on the comparative marginal rates of return.

- Finally, if it were possible for firms to get a benefit–cost ratio of greater than 1:1 now then why are they not doing so? One potential reason for this was touched on at the end of chapter 2 – capital market failures. However, there is insufficient evidence of such failures to conclude that they are significant.

From the information available there is no reason to suspect any significant market failure when it comes to the private R&D benefits. Lattimore (1997) concludes his discussion of the topic by admitting that it is currently not possible to know whether the private sector is under or over investing in R&D, based on private returns. This is one area that could benefit from some additional research.

Additional flow-on and spillover benefits

In addition to the private benefits, R&D investments will result in public benefits - both in the form of *flow on* and *spillover* benefits. As outlined in chapter 2, the primary rationale for government support of R&D is the existence of spillover benefits. However, while the level of spillovers is vital in determining the appropriateness and efficiency of the R&D Tax Concession (or any other R&D program), it is also the variable about which we know the least.

While the existence of flow-on benefits does not present a justification for government intervention, the flow-on benefits from R&D must still be calculated in order to give a complete account of all benefits. Previous studies have often treated flow-on benefits and spillover benefits together so that the following estimates actually represent the combination of flow-on and spillover benefits (here referred to simply as spillovers).

The intangible nature of spillover benefits makes such benefits very difficult to measure, and previous studies have produced estimates that vary considerably. However, while estimates of spillovers must always be treated with caution there are some indicators that may be useful in an Australian context (see also table 5.4):

- most Australian reviews of R&D subsidy programs have estimated spillover benefits at between $0.25 and $0.90 for each dollar of R&D invested;
- an estimate of $5.52 can be derived under various assumptions in the Industry Commission's 1995 study into R&D;

- in the BIE (1993) review of the R&D Tax Concession, a range from $0.66 to $0.90 spillover benefit was used;
- in the Lattimore (1997) review of the R&D Tax Concession, $0.70 spillover benefit was used;
- in the Productivity Commission's 2003 report on the Pharmaceutical Industry Investment Program, a range from $0 to $0.90 was used; and
- an estimate of $1.22 can be derived from Dowrick.

In addition to these Australian estimates, various international studies have been undertaken to measure the private and/or social benefits from R&D. By calculating the difference between the total and private benefits, it is possible to get estimates of public (spillover) benefits of around $1.06. Further details are provided in table 5.4.

5.4 **Estimates of present value returns from R&D**

	Study location	*Public benefit*	*Total benefit from R&D (private plus public)*
		%	%
Productivity Commission 2003 (clinical R&D)	Aust	25	
Productivity Commission 2003 (pre-clinical R&D)	Aust	58	
Lattimore 1997	Aust	70	
BIE (1993)	Aust	66–90	
Mansfield various (applied R&D)	Foreign		106
Scherer 1993 (product R&D)	Foreign		110–127
Derived from Industry Commission 1995	Foreign	106	
Derived from Industry Commission 1995, tables QA3 and QA4	Foreign	106	
Derived from Dowrick 2002	Aust	122	235
Griliches and Lichenberg 1984 (product R&D)	Foreign		100–130
Griliches and Mairese 1990 (USA)	Foreign		136
Griliches and Lichenberg 1984 (process R&D)	Foreign		246–300
Many studies, Industry Commission 1984, table QA3 (all R&D)	Foreign		361
Derived from Industry Commission 1995	Aust	382	
Mansfield various (basic R&D)	Foreign		468
Derived from Industry Commission	Austr	552	

Based on previous Australian estimates and international estimates a broad range of between $0.30 and $1.30 seems reasonable, with a mid-point of 80 per cent. This range includes all estimates used in previous reviews of the R&D Tax Concession. However, while it may be useful to consider a reasonable estimate for spillovers, the ambiguity surrounding any spillover estimate necessitates a broad sensitivity analysis and a non-dogmatic statement of conclusions.

Additional issues with spillovers

Various studies show that the total returns from R&D seem to vary substantially depending on whether the R&D is product or process oriented, applied or basic; with process oriented and basic R&D scoring considerably higher and suggesting the possibility of high spillovers in these areas. In Australia, more basic R&D is conducted by the public institutions rather than private companies – which may indicate that spillovers from the R&D Tax Concession are less than the national average.

While we are not able to derive a specific estimate for spillover benefits from the survey responses, some of the survey answers provide some interesting additional information.

R&D spillovers exist when a firm is unable to capture benefits that accrue to others. To the degree that a firm can capture those benefits, spillovers will be reduced. This is the rationale behind patents, where the government provides a mechanism for firms to capture the knowledge spillover benefits from their innovations. However, it should be noted that patents are not the only way in which a firm can protect its innovations. Ninety-five per cent of firms indicated that they had some form of protection from being copied.

The most common indicated form of protection against being copied was the complexity of production, which helped protect 69 per cent of firms from having their R&D copied. Other common forms of protection included quick speed to market and ownership of key technology inputs. However, the most effective form of protection was patents, which received the highest rating of importance (8.6 out of 10). All forms of protection were considered relatively effective, with scores ranging from 6 to 8.6. It is not possible to draw any quantitative conclusions from these data, however it seems to indicate that firms often make use of multiple strategies for protecting their R&D and hence minimising spillovers.

Another survey question asked tax concession participants whether they have been a beneficiary of R&D done previously by other firms. While 30 per cent indicated that they had, one third of these were due to the purchase of intellectual property. This illustrates the effectiveness of patents, which have internalised one third of what would have been spillover benefits.

Spillover benefits accrued to 20 per cent of firms, mostly because of unprotected R&D. Other mechanisms for spillovers were staff transfer, collaboration and reverse engineering. Beneficiaries of spillovers rated the importance of the previous R&D as moderately important (5.5 out of 10).

It is uncertain exactly how this information can be interpreted. If we do accept that only 20 per cent of firms gain spillover benefits and if we attribute half of their benefit to the spillover, then approximately 10 per cent of R&D benefits are due to spillovers derived from previous R&D. As we previously estimated the private benefit-cost ratio to be 3.4 to 1, this implies that the spillover benefit would be 0.34 to 1, or 34 per cent, which is within our 30 to 130 per cent range.

In the end, it is not possible to come up with a definitive point estimate for the spillover rate. Unlike the estimated inducement, it is not possible to submit spillover estimates to robust sensitivity tests to validate specific assumption, and so considerable caution is required in drawing conclusions based on specific spillover estimates.

6 Analysis and conclusions

The previous chapters have provided us with the information we need to analyse the effectiveness and efficiency of the R&D Tax Concession. Based on R&D theory, previous studies and the 2003 survey we have been able to determine the benefits and costs of the tax concession. We are now able to review the program, conduct some sensitivity analysis and offer some conclusions.

Benefit–cost analysis

A review of the previous two chapters provides us with the following information on the benefits and costs of the R&D Tax Concession program (table 6.1).

The information in table 6.1 excludes estimates for the inducement rate and the spillover rate, and so the total benefit is not specified. Because of the vital importance of these two variables to the outcome of this analysis and due to the uncertainty surrounding these estimates, we have chosen not to pick a point estimate but rather consider a matrix of possible different scenarios.

6.1 **Benefits and costs of R&D Tax Concession scheme**

Type of benefit	*Type of cost*
▪ Transfer from government to companies. – This benefit is equal to the budget cost of the scheme * (1 – inducement rate) * 0.8 (1 – leakage)	▪ Budget cost of scheme = $280 million ▪ Efficiency cost = $85 million ▪ Administrative cost = $10 million
▪ Private benefit from induced R&D – This benefit is equal to the budget cost of the scheme * inducement rate * 0.8 (1 – leakage)	▪ Compliance cost = $35 million ▪ Rent-seeking cost = unknown
▪ Spillover & flow-on benefits from induced R&D – This benefit is equal to the budget cost of the scheme * inducement rate * spillover rate	
Total = variable	Total = $410 million

Table 6.2 below shows the benefit–cost ratio for each of 84 different scenarios considering inducement rates between 40 and 100 per cent and spillover rates from 20 to 200 per cent, as well as the high-point spillover estimates of 382 and 552 per cent. The lightly shaded area in the matrix indicates those outcomes where the benefit–cost ratio is less than 1:1. The dark shaded area in the matrix indicates an area where the outcomes are marginally positive (between 1:1 and 1.2:1), and the medium shading shows those outcomes with a positive outcome (above 1.2:1).

Sensitivity analysis

Sensitivity analysis for spillovers and inducement is not necessary as it is already available in table 6.2. However, there are other variables that can be modified to determine their importance. To measure the sensitivity of the conclusions to these variables it is necessary to have a benchmark. We will set this benchmark at a 1:1 benefit–cost ratio, and then observe how much the benefit–cost ratio changes as we change certain variables.

The above outcomes are based on several assumptions, which can be tested for sensitivity. Assumptions to be tested include the estimated efficiency cost of the R&D Tax Concession of 30 per cent, the leakage estimate of private benefits to foreign shareholders of 20 per cent and the budgetary cost of the tax concession being $280 million. The result of the sensitivity analysis can be seen in table 6.3 below.

6.2 **Benefit to cost ratios by spillover and inducement rates**

Inducement rates	Spillover rates: Present values $ benefits per $ of R&D											
	0.2	*0.4*	*0.6*	*0.8*	*1.0*	*1.2*	*1.4*	*1.6*	*1.8*	*2.0*	*3.82*	*5.52*
		← Preferred range →										
0.40	0.60	0.65	0.71	0.76	0.82	0.87	0.93	0.98	[illegible]	[illegible]	1.58	2.07
0.50	0.61	0.68	0.75	0.82	0.88	0.95	[illegible]	[illegible]	[illegible]	1.22	1.84	2.45
0.60	0.63	0.71	0.79	0.87	0.95	[illegible]	[illegible]	[illegible]	1.28	1.36	2.10	2.83
0.70	0.64	0.73	0.83	0.93	[illegible]	[illegible]	1.21	1.31	1.40	1.50	2.36	3.21
0.80	0.65	0.76	0.87	0.98	[illegible]	[illegible]	1.31	1.42	1.52	1.63	2.62	3.59
0.90	0.67	0.79	0.91	[illegible]	[illegible]	1.28	1.40	1.52	1.65	1.77	2.88	3.97
1.00	0.68	0.82	0.95	[illegible]	1.22	1.36	1.50	1.63	1.77	1.91	3.14	4.35

Source: CIE model.

6.3 **Sensitivity analysis**

Variable	*Starting estimate*	*Pessimistic estimate*	*Optimistic estimate*
Efficiency cost of the R&D Tax Concession (30, 40, 20 per cent)	1.0	0.94	1.07
Leakage estimate of private benefit (20, 30, 10 per cent)	1.0	0.93	1.07
Budget cost of the R&D Tax Concession ($280 million, $180 million, $380 million)	1.0	0.99	1.01

Source: CIE calculations.

Moderate changes to the estimated efficiency cost of the tax concession, the foreign leakage, the flow-on benefits and the estimated marginal private R&D benefit does not have a significant impact on the results. In all instances, the benefit–cost ratio stays within the range of 0.9 to 1.1 to 1.

The 175 per cent Premium Tax Concession and R&D Tax Offset

The above analysis has tried to measure the benefits and costs of the 125 per cent R&D Tax Concession scheme, excluding the 175 per cent Premium Tax Concession and the R&D Tax Offset. As these additional elements of the tax concession scheme are relatively new it is difficult to draw any definite conclusions from the data. A further review to estimate the marginal impact of these elements may be of value in several years when more data is available.

According to the Tax Expenditure Statement (2003), the total cost of the R&D Tax Offset is estimated at around $10 million. Because of the greater flexibility of the R&D Tax Offset it would be expected that its value would be considered higher than the general 125 per cent tax concession and so it would be expected to encourage more R&D investment.

In 2002-03, about 9 per cent of firms used the 175 per cent Premium Tax Concession, which provides support specifically for additional R&D expenditure. However, because the Premium Tax Concession is three times as generous as the standard tax concession it is estimated to make up nearly 30 per cent of the cost.

Evidence from previous studies has indicated that there is a diminishing inducement effect as the size of the tax concession gets larger. However, it is not clear that such conclusions can necessarily be applied to the Premium Tax Concession as it impacts on investment decisions in a different way. As the survey questions do not address this issue specifically and the R&D demand model does not include economy-wide constraints, we are unable to make any estimate of this effect.

Conclusions

This report has considered the appropriateness, the effectiveness and the efficiency of the R&D Tax Concession. To the degree that spillovers are significant and not considered by the free market, there exists a rationale for government intervention. In this regard it is *appropriate* to consider the use of the R&D Tax Concession.

The effectiveness of the tax concession scheme was measured by the amount of additional R&D that was induced due to the scheme. While estimates of inducement vary, it seems reasonable to conclude that the inducement level is probably between 50 and 90 per cent and so could be considered *effective*.

The *efficiency* of the R&D Tax Concession scheme is less clear. The efficiency was tested using a comprehensive benefit–cost framework to evaluate what net impact the program had on Australia. However, the results of this analysis rest crucially on an estimate of spillover benefits, for which there is little hard evidence. Using the preferred ranges of inducement and spillovers, the range of potential benefit–cost ratios is between 0.7 to 1 up to 1.3 to 1.

The uncertainty that surrounds the important spillover estimate and the marginal nature of the above conclusions makes it difficult to draw a firm conclusion on the program's efficiency.

Appendixes

A The benefit–cost framework

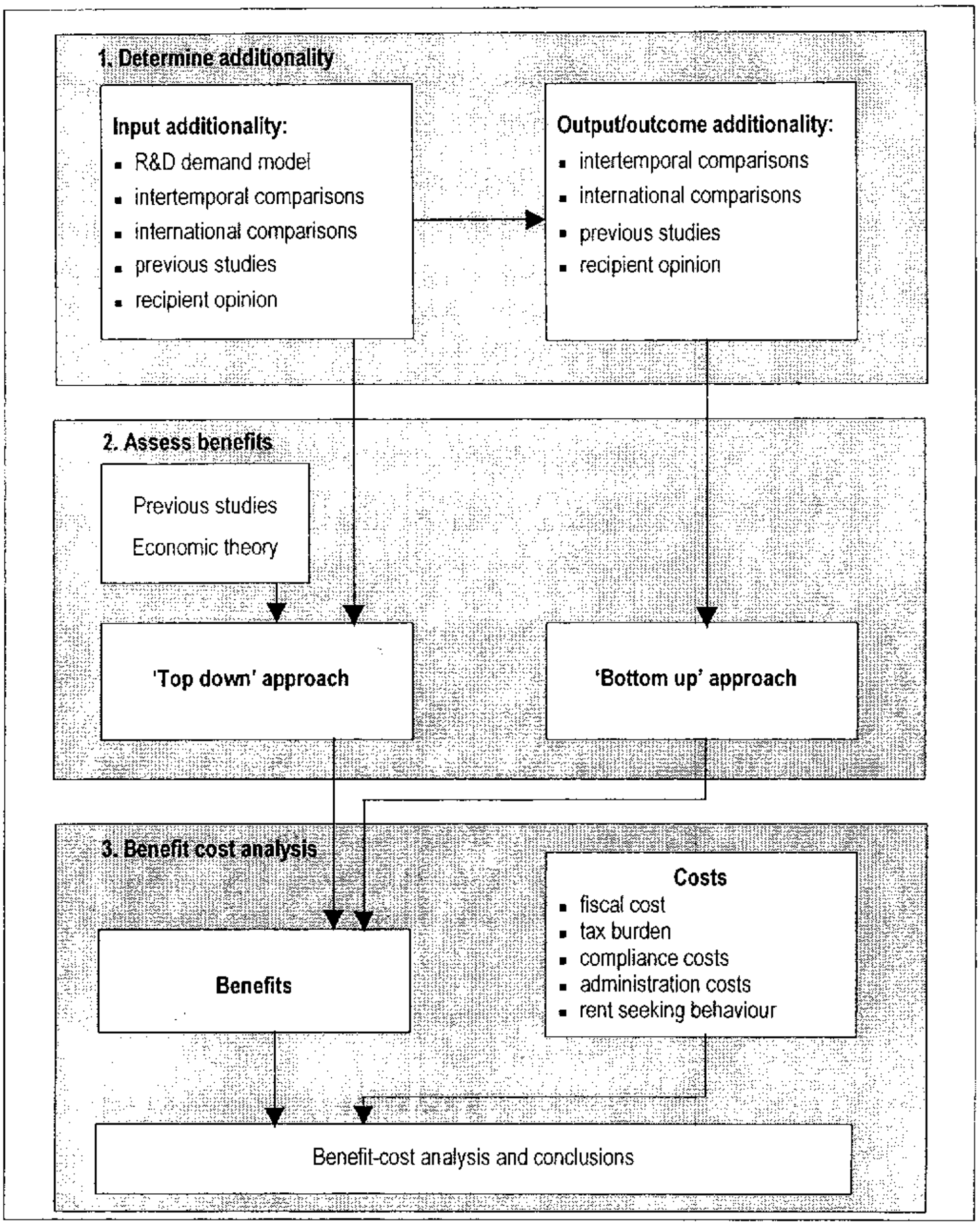
Our framework for review of the R&D Tax Concession Program will go through three broad stages, as set out in chart A.1 and outlined below.

- Determining additionality of research due to the R&D Tax Concession.
  - It will be necessary to determine the additionality of R&D inputs (that is, firm expenditure on R&D), R&D outputs (that is, new products, patents, etc.) and R&D outcomes (that is, lower costs, more sales, etc.).
- Working out the benefits (public and private) due to the additionality.
  - We will use two approaches — a 'bottom up' approach will utilise information on the additionality of outputs and outcomes, while a 'top down' approach will use information on the additionality of inputs and other information.
- Assessing the net benefits in a cost–benefit framework.
  - The benefits of additional R&D derived from the tax concession will be compared with the costs of the program (including fiscal cost, cost of taxation, compliance cost, administration cost and rent seeking).

In addition, the approach will need to consider the underlying justification of the tax concession program. Information on this will be derived both from a review of relevant literature and principles, and from the survey responses.

While focusing on the concession package as a whole, and while in principle our analysis will be able to look at each element of the package, our examination of the 175 per cent concession and the offset will necessarily be preliminary.

A.1 **Stages of analysis**



Determining additionality

In assessing the national benefit of the R&D tax concession it is necessary to work out how much extra benefit is received due to the tax concession (that is, the additionality). We will use several methods for determining the additionality of inputs, outputs and outcomes. These include:

- surveying tax concession recipients about the perceived additionality;
- researching previous studies and previous reports;

- comparing R&D inputs, outputs and outcomes across different countries (international comparisons);
- comparing R&D inputs, outputs and outcomes across different times (inter-temporal comparisons); and
- using a model of R&D demand, based on economic theory.

All of these options have strengths and weaknesses. The first five methods have been previously discussed, however the last method (using an R&D Demand model) may prove to be the most informative with regards to input additionality.

Using an R&D Demand model

A literature review and survey responses will be the main source of information for this component.

Chart A.2 indicates that there are a number of factors determining the demand for R&D – that is, the amount of R&D a firm will undertake as part of its operations.

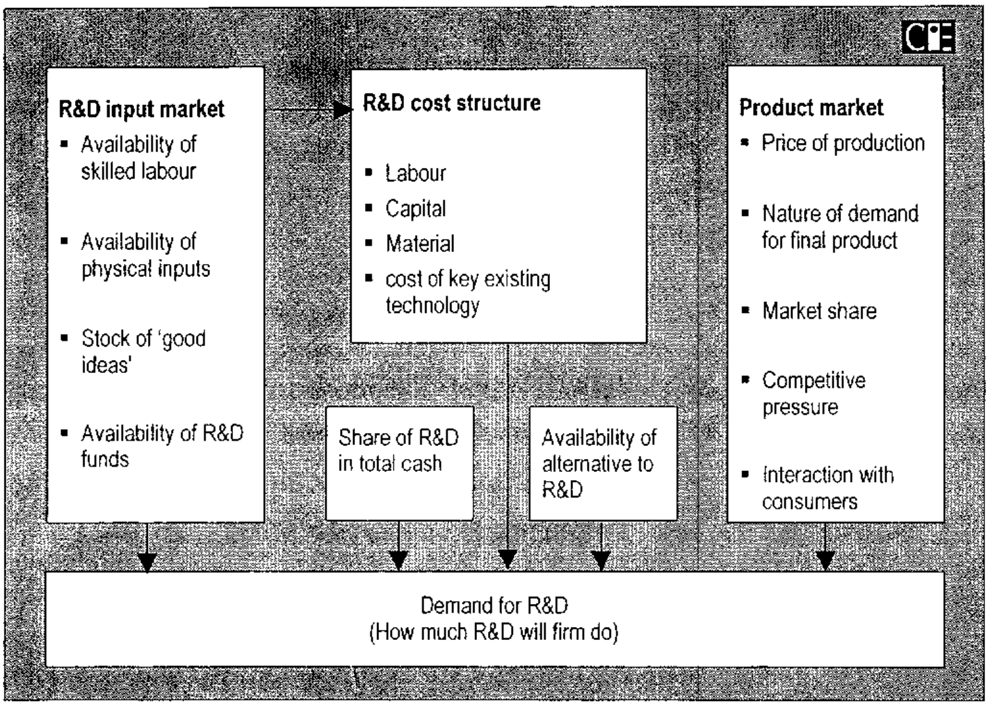
These factors relate to:

- the R&D input market, including things such as the availability of skilled labour, the scarcity of appropriate physical inputs, the stock of good ideas and importantly, the availability and cost of R&D funds;
- the cost structure of undertaking R&D, including the cost shares of labour, capital and material inputs as well as the cost of obtaining key IP to build on;
- the share of R&D in total final product costs;
- the availability of alternatives to R&D, including, for example, the potential for purchasing products 'off the shelf'; and
- characteristics of the product market, including the nature of demand for the final product, the firm's market share, competitive pressures in the market and so on.

Understanding the relative importance of these various factors, and the ways in which they interact for a particular firm or industry will provide:

- an understanding of the key constraints to R&D activity and how these may change; and
- an estimate of the influence of the tax concession on R&D activity by providing a model of how the demand for R&D changes as the relative cost of R&D changes (as a result of the concession).

A.1 **Factors affecting R&D**



Assessing benefits

As outlined previously, we will be using both a top down approach and a bottom up approach.

Top down analysis of the impact of R&D

Using data on input additionality as well as information regarding the impact of R&D (from previous research and economic theory), we will be able to generate a top down estimate of the impact of the increase in R&D on economic outcomes.

This top down estimate will be used as one source of information on the benefits of the tax concession, and can be used as a cross check for the outcomes of the bottom up approach.

Because we expect that the R&D undertaken by concession eligible firms will be significant at a macroeconomic level, this top down analysis will provide a useful component of the overall assessment.

Bottom up analysis

Information collected from the survey will be used to undertake a bottom up analysis of R&D outcomes. We expect a variety of key economic outcomes from the R&D including:

- lower costs;
- increased productivity;
- new and better products;
- intellectual property;
- improved labour skill; and
- others factors that, for example, could contribute to knowledge spillovers.

In addition, we will need to include survey questions about key performance indicators such as those listed in paragraph 4.11 of the Request for Tender. It is important to note, however, that in collecting this information, our primary objective will be to allow the measurement of economic outcomes to contribute to the overall quantitative benefit-cost analysis.

We anticipate that the information will be collected on an individual company basis (we will be basis the survey recipients in the AusIndustry database). This means that the outcomes we ask about will be at an individual level. Where a company is part of a group, some key questions will need to identify this.

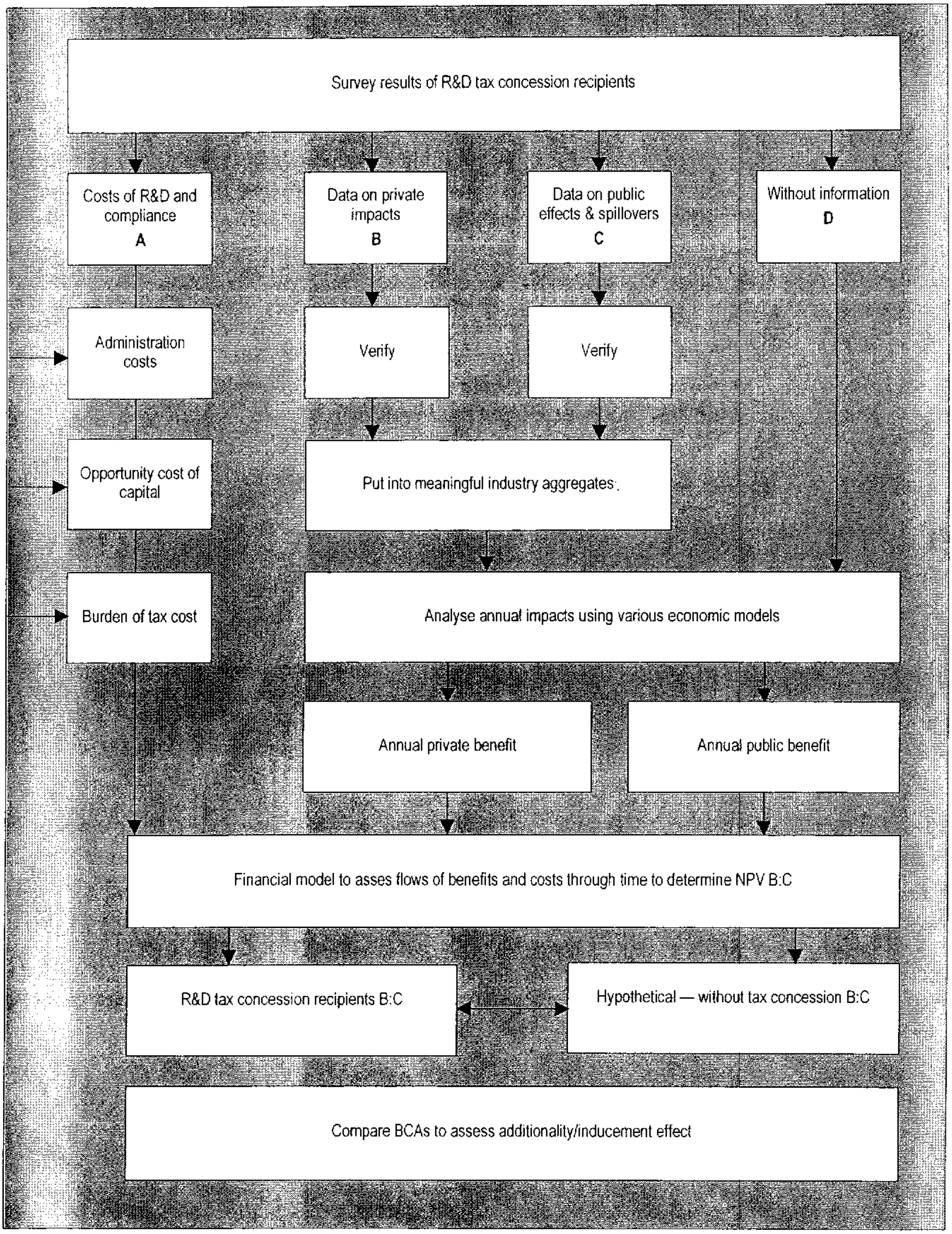
These outcomes will be a mix of both private and public which the analysis will need to carefully separate. We will then be able to manipulate this data to determine the impact of R&D on economic outcomes.

Cost–benefit analysis

Each of the elements outlined above will be brought together in an overall benefit–cost analysis. The broad structure of this is illustrated in chart A.3.

The benefits of the concession will consist of the outcomes of the additional R&D that is induced by the concession. This will include the various productivity improvements, costs savings and so on. For the bottom up analysis, the value of these various improvements will be assessed by

A.1 **Overall cost–benefit framework**

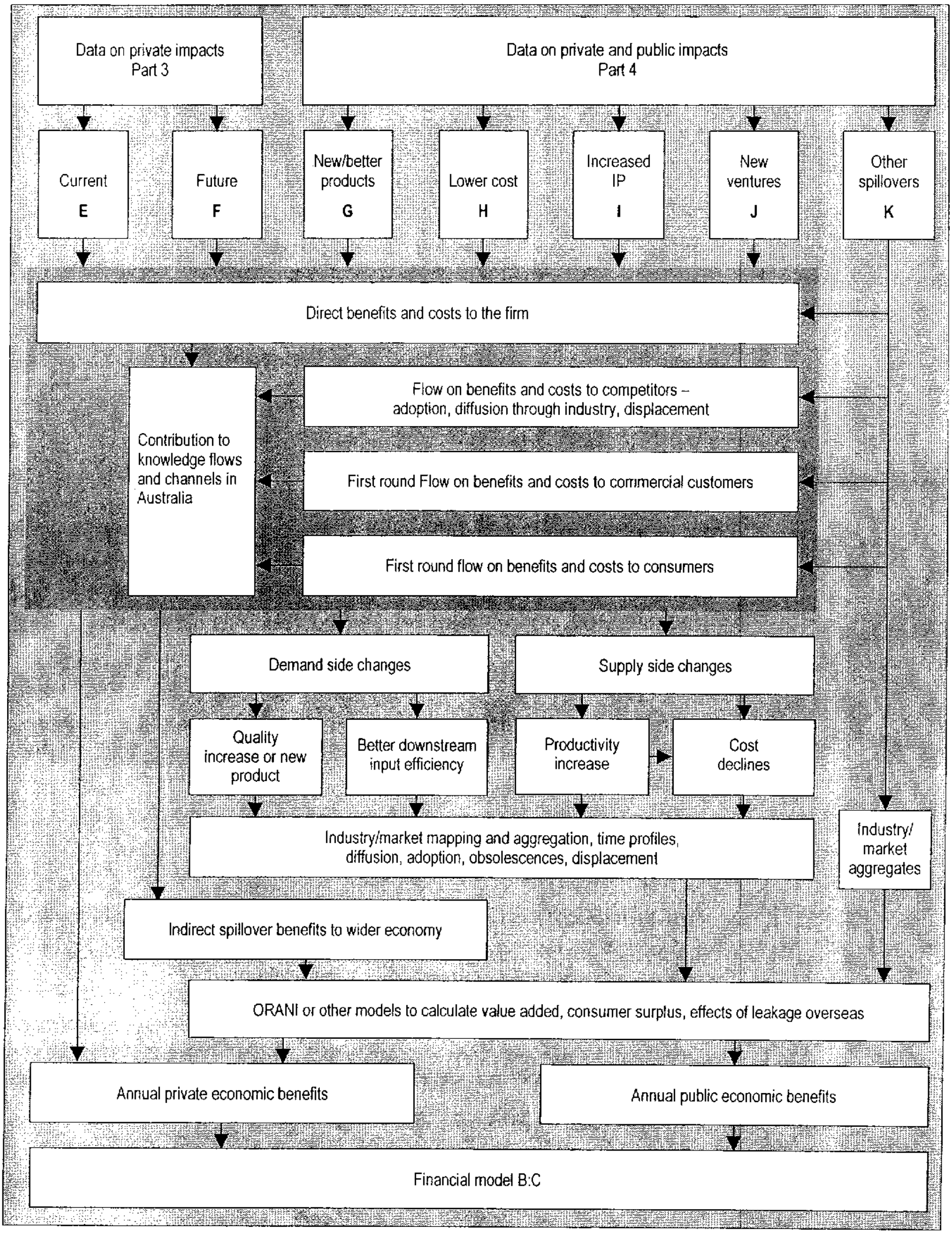


simulating them in our economy-wide framework (the ORANI model). This will allow us to capture the flow-on effects of the initial outcomes and will allow us to produce an economy-wide benefit measure.

A combination of the flow-on effects and other survey data about protection of IP, collaboration and diffusion to competitors will enable us to assess knowledge spillovers and other spillovers relating to OH&S and pollution, for example. The process of assessing the private and public impacts is illustrated in chart A.4.

The costs of the concession will include the costs of the R&D undertaken, compliance costs in getting the concession, administrative costs, the opportunity cost of capital and the welfare cost of tax raising (in this case in the form of taxes foregone through the concession). The streams of costs and benefits will be compared in an appropriate financial model to account for time profiles, discount rates and so on.

A.2 **Private and public benefits**



B Mathematical appendix on the R&D Demand model

The first step of the evaluation is to identify firms' additional R&D induced by the R&D Tax Concession. The design of the survey questionnaire enables the use of several approaches to derive the induced R&D. Two approaches are discussed below.

Induced R&D: simple model

R&D expenditure (E) can be broken into several components: rent of building or plant-machinery (K), skilled labour (L), general inputs and materials (M), specialised technical or laboratory equipment (T), collaboration and/or contracted out R&D (C) and other inputs (O):

$$E = K(P_K, P_{-K}) + L(P_L, P_{-L}) + M(P_M, P_{-M}) + T(P_T, P_{-T}) + C(P_C, P_{-C}) + O(P_O, P_{-O})$$

where P_i is the price of individual input, $i \in \{K, L, M, T, C, O\}$; and P_{-i} is prices of inputs other than i. The extra R&D expenditure induced by tax concession is

$$\frac{\partial E / E}{\partial t} = \sum_{i \in K,L,M,T,C,O} \sum_{j \in K,L,M,T,C,O} \varepsilon_{ij} s_i \frac{\partial P_j / P_j}{\partial t},$$

where t is the R&D Tax Concession, 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 question 2.2 directly. According to the tax concession regulation, a 125 per cent tax concession is equivalent to 7.5 per cent reduction in R&D costs in the current corporate income tax rate of 30 per cent. This implies that $\frac{\partial P_j / P_j}{\partial t}$ is 7.5.

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

$$\frac{\partial E/E}{\partial t} = \frac{7.5}{20}\sum_i (s_i \varepsilon_i)$$

The parameter 7.5 comes from the fact that a 125 per cent R&D Tax Concession is equivalent to 7.5 per cent reduction in cost in the current corporation tax rate of 30 per cent. And 20 is used to scale down the elasticity given by question 2.2 (ε_i) to percentage changes in R&D activity with respect to 1 percent reduction in each component of cost. The results of this approach are given under 'simple method (a)'.

The above calculation may overlook important constraints on R&D activity. 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:

$$\frac{\partial E}{\partial t} = f^O \frac{7.5}{20}\sum_i (f_i^R s_i \varepsilon_i)$$

The adjusting factors, *f*, are calculated according to the ratings firms put to each constraint:

$$f = 1 - (r/10)^2$$

The value of the adjusting factor lies between 0 and 1. If a firm puts a rate of 10 to one factor, it means that factor is highly constraint and the cost reduction caused by tax concession does not affect the firm's demand for R&D, in this case the adjusting factor is 0. On the other hand, if a rate of zero 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.

A mapping from the constraint given in answers to question 2.1 to the cost components in question 2.2 is given in table B.1.

In 'simple method (b)', both constraints on opportunity and motivation and resource availability are considered, while in 'simple method (c)' only the constraints on resource availability are included.

Induced R&D: direct and historical

Question 2.4 gives the information about changes in R&D expenditure between 1995-96 and 2001-02 (ΔE) and the relative importance of various factors affecting the change (rating). The average inducement of tax concession could be easily derived from the information:

$$\text{tax concession induced change} = \Delta E \times \frac{\text{rating of "changes to the rate of tax concession"}}{\text{sum of ratings}}.$$

Question 2.5 gives elasticity of R&D expenditure with respect to tax concession rate.

Induced R&D: a 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

$$\max \quad Pf(R, O^Q) - P_R(1+T_R)(1+\tau)R - P_O^Q K^Q,$$

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 2.1 - for example, 2.1(l) 'inadequacy of intellectual property protection', and the impact of each factor rated from 1 to 10. 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:

$$T_R = (R/R_0)^{\rho}$$

As $\rho \to \infty$ the firm faces an upper bound of R_0 on the quantity of R&D demanded. As $R_0 \to \infty$ with $\rho > 0$ there are no quantitative constraints on R&D. Values for ρ and R_0 could be imputed based on ratings in 2.1 (mainly from sections 'Opportunity and motivation' and 'Government constraints', with high ratings implying high ρ and low R_0) 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 above 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 supplementary question S.9. 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:

$$\min \begin{Bmatrix} r(1+T_K)K + w(1+T_L)L + P_M(1+T_M)M + \\ P_T(1+T_T)T + P_C(1+T_C)C + P_O(1+T_O)O \end{Bmatrix}$$

$$\text{s.t.} \quad R^D = g(K, L, M, T, C, O)$$

$\{T_\Theta : \ \Theta \in \{K, L, M, T, C, O\}\}$ are the price-equivalents of constraints on inputs to the R&D activity. Some factors imposing such constraints are listed in 2.1, 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:

$$T_\Theta = (\Theta/\Theta_0)^{\rho_\Theta}, \quad \forall\Theta \in \{K, L, M, T, C, O\}$$

Values for ρ_Θ and Θ_0 could be imputed based on ratings in the resource availability section 2.1 (mainly from the section 'Resource availability', with high ratings implying high ρ_Θ and low Θ_0) and the quantitative responses in section 2.2. The first order conditions are:

$$\begin{aligned}
\lambda g_K &= r(1 + T_K(1 + \rho_K)) \\
\lambda g_L &= w(1 + T_L(1 + \rho_L)) \\
\lambda g_M &= P_M(1 + T_M(1 + \rho_M)) \\
\lambda g_T &= P_T(1 + T_T(1 + \rho_T)) \\
\lambda g_C &= P_C(1 + T_C(1 + \rho_C)) \\
\lambda g_O &= P_O(1 + T_O(1 + \rho_O))
\end{aligned}$$

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:

$$g = Kg_K + Lg_L + Mg_M + Tg_T + Cg_C + Og_O$$

so, consequently,

$$\lambda = \frac{\begin{bmatrix} r(1 + T_K(1 + \rho_K))K + w(1 + T_L(1 + \rho_L))L + P_M(1 + T_M(1 + \rho_M))M \\ + P_T(1 + T_T(1 + \rho_T))T + P_C(1 + T_C(1 + \rho_C))C + P_O(1 + T_O(1 + \rho_O))O \end{bmatrix}}{R^D}$$

As noted previously, $P_R' = \partial\lambda/\partial R^D$ 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:

$$\lambda\sum\nolimits_{\Theta\in\{K,L,M,T,C,O\}} g_{K\Theta}\left(\partial\Theta/\partial R^D\right)+g_K\left(\partial\lambda/\partial R^D\right)=r(T_K/K)(1+\rho_K)\rho_K\left(\partial K/\partial R^D\right)$$
$$\lambda\sum\nolimits_{\Theta\in\{K,L,M,T,C,O\}} g_{L\Theta}\left(\partial\Theta/\partial R^D\right)+g_L\left(\partial\lambda/\partial R^D\right)=w(T_L/L)(1+\rho_L)\rho_L\left(\partial L/\partial R^D\right)$$
$$\lambda\sum\nolimits_{\Theta\in\{K,L,M,T,C,O\}} g_{M\Theta}\left(\partial\Theta/\partial R^D\right)+g_M\left(\partial\lambda/\partial R^D\right)=P_M(T_M/M)(1+\rho_M)\rho_M\left(\partial M/\partial R^D\right)$$
$$\lambda\sum\nolimits_{\Theta\in\{K,L,M,T,C,O\}} g_{T\Theta}\left(\partial\Theta/\partial R^D\right)+g_T\left(\partial\lambda/\partial R^D\right)=P_T(T_T/T)(1+\rho_T)\rho_T\left(\partial T/\partial R^D\right)$$
$$\lambda\sum\nolimits_{\Theta\in\{K,L,M,T,C,O\}} g_{C\Theta}\left(\partial\Theta/\partial R^D\right)+g_C\left(\partial\lambda/\partial R^D\right)=P_C(T_C/C)(1+\rho_C)\rho_C\left(\partial C/\partial R^D\right)$$
$$\lambda\sum\nolimits_{\Theta\in\{K,L,M,T,C,O\}} g_{O\Theta}\left(\partial\Theta/\partial R^D\right)+g_O\left(\partial\lambda/\partial R^D\right)=P_O(T_O/O)(1+\rho_O)\rho_O\left(\partial O/\partial R^D\right)$$

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:

$$\partial\lambda/\partial R^D=\frac{\begin{bmatrix} rT_K(1+\rho_K)\rho_K\left(\partial K/\partial R^D\right)+wT_L(1+\rho_L)\rho_L\left(\partial L/\partial R^D\right)+ \\ P_M T_M(1+\rho_M)\rho_M\left(\partial M/\partial R^D\right)+P_T T_T(1+\rho_T)\rho_T\left(\partial T/\partial R^D\right)+ \\ P_C T_C(1+\rho_C)\rho_C\left(\partial C/\partial R^D\right)+P_O T_O(1+\rho_O)\rho_O\left(\partial O/\partial R^D\right) \end{bmatrix}}{R^D}$$

The previous seven equations are all required to define $\partial\lambda/\partial R^D$.

One advantage of the structural approach over the direct approach 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.

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_0. 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_0 is a location parameter for the constraint, intuitively, it determines the level near which the constraint starts to 'bite'. For example, as $\rho_\Theta \to \infty$ it is the upper bound on the quantity. Values for ρ_Θ and Θ_0 should somehow be sensibly related to the ratings in question 2.1 - increasing and decreasing functions of the ratings, as noted above. 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_0. As a first approach, for a given value of ρ_Θ (to be determined as described at the end of this section), Θ_0 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 2.1 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 3.2: a high share of novel technology in R&D assigns a high value of T_Θ. A starting point will be to use that share directly.

A formal treatment of Ω_Θ is:

$$\Omega_\Theta = \left[\sum_r b_r S_r^c\right]^{1/c} \quad \sum_r b_r = 1$$

where b_rs are weights which map the relevant rating from question 2.1 to the price-equivalent constraint. Table B.1 provides the mapping.

B.1 Mapping of question 2.1 answers to R&D inputs

	Rent, building or plant/ machinery	*Skilled labour*	*General inputs and materials*	*Specialised technical or laboratory equipment*	*Collaboration*	*Contracted out R&D*	*Other*
2.1.a							
2.1.b							
2.1.c_1							
2.1.c_2							
2.1.c_3							
2.1.c_4							
2.1.d	1		1		1	1	
2.1.e		1					
2.1.f					1	1	
2.1.g				1			
2.1.h							
2.1.i	1	1	1	1			
2.1.j		1					
2.1.k				1	1	1	
2.1.l							
2.1.m							

The value $c = 1$ provides a weighted-arithmetic average of the ratings S_r, $c \to 0$ a geometric average and $c \to \infty$ the maximum of the ratings. We could start with $c = 1$, and consequently experiment with $c = 2, 5, 10$.

The mapping between the average rating and the initial price-equivalent, with a maximum initial price-equivalent $\hat{T}_\Theta = 100\%$ and various values of a, is shown in table B.2.

B.2 **Mapping average ratings to initial price-equivalents**

Average rating (Ω_Θ)	*Initial price-equivalent with a=0.5*	*Initial price-equivalent with a=1*	*Initial price-equivalent with a=2*	*Initial price-equivalent with a=3*
	%	%	%	%
1	32	10	1	0
2	45	20	4	1
3	55	30	9	3
4	63	40	16	6
5	71	50	25	13
6	77	60	36	22
7	84	70	49	34
8	89	80	64	51
9	95	90	81	73
10	100	100	100	100

Sensitivity analysis can be performed with respect to the parameters a and $\hat{T}_\Theta$.

Once $\hat{T}_{\Theta 0}$ is determined, Θ/Θ_0 or Θ_0 (Θ being derivable from survey responses) can be derived through $\hat{T}_{\Theta 0} = (\Theta/\Theta_0)^{\rho_\Theta}$ 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 2.2.

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 above. 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:

$$\Sigma_i \alpha_i (Q_i/Q)^{\beta_i} = 1$$

The parameters β_i influence the magnitudes of the associated own-price effects, such as those contained in question 2.2, 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, $\partial Q/\partial Q_j$ in the current notation. If the CRESH definition is partially differentiated with respect to Q_j then the expression obtained is:

$$\Sigma_i \alpha_i \left(\delta_{ij}\beta_i \left(Q_i^{\beta_i - 1}/Q^{\beta_i}\right) - \beta_i \left(Q_i^{\beta_i}/Q^{\beta_i + 1}\right) \cdot \partial Q/\partial Q_j\right) = 0$$

so

$$\begin{aligned} \partial Q/\partial Q_j &= \frac{\alpha_j \beta_j \left(Q_j^{\beta_j - 1}/Q^{\beta_j}\right)}{\Sigma_i \alpha_i \beta_i \left(Q_i^{\beta_i}/Q^{\beta_i + 1}\right)} \\ &= \frac{\alpha_j \beta_j (Q_j/Q)^{\beta_j - 1}}{\Sigma_i \alpha_i \beta_i (Q_i/Q)^{\beta_i}} \end{aligned}$$

The definition of $\partial\lambda/\partial R^D$ (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 with respect to Q_k to yield:

$$\partial^2 Q/\partial Q_j \partial Q_k = \left[\begin{aligned} &(\beta_j - 1)(\delta_{jk}/Q_j - (1/Q)(\partial Q/\partial Q_k)) + \\ &\frac{\Sigma_i \alpha_i \beta_i^2 (Q_i/Q)^{\beta_i - 1} \left(\delta_{ik}/Q - (Q_i/Q^2)(\partial Q/\partial Q_k)\right)}{\Sigma_i \alpha_i \beta_i (Q_i/Q)^{\beta_i}} \end{aligned} \right] (\partial Q/\partial Q_j)$$

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 hypothetical question 3.11. The parameters in *g* are the subject of sensitivity testing to determine their influence on supply-side parameters imputed from questions 2.1 and 2.2.

C The questionnaire

The details of the questionnaire issued to R&D Tax Concession recipients are published in this appendix.

R&D Tax Concession Program

Survey of R&D Tax Concession Recipients

June 2003

INDUSTRY
TOURISM
RESOURCES

Thank you for participating in this survey. This survey is an essential part of the evaluation of the R&D Tax Concession program. It is important for the Government to assess the performance of its programs to support R&D through evaluations of this kind. The survey requests information on the financial impact on your firm of the R&D Tax Concession and aims to assess the likely flow-on effects to industry and consumers.

Although we ask for specific figures, in many cases these may not be known with a high degree of accuracy. Therefore, in most cases **your best estimate is what we require**. All information you provide shall be treated as commercial-in-confidence.

In recognition of the time constraints of most of the survey participants, the survey has been split into two sections. The main part includes those questions essential to the successful evaluation of the R&D Tax Concession program and is expected to take approximately 1-2 hours to complete.

Time permitting, it would also be appreciated if you could complete the supplementary section, which we expect should take approximately half an hour to complete.

A Microsoft Word version of the questionnaire has been sent to you. Please complete the form electronically by checking relevant boxes, entering numbers or words directly into the shaded fields provided in the Word version. When you first open the document it appears as a new document. Please save it with a new name – we suggest you use your Australian Company Number as the title.

Please return this survey by **close of business Wednesday, 23 July 2003** to the following address, **preferably by email**, although earlier receipt would be appreciated.

By email: rdtaxreview@industry.gov.au
By fax: 02 6213 6106
By mail: Manager, Business R&D Policy, Innovation Division
Department of Industry, Tourism and Resources
GPO Box 9839, Canberra ACT 2601

If you have any queries on the survey, please do not hesitate to contact us on 1800 003 183 (helpline).

Commonwealth Government
Statistical Clearing House Approval Number: 01393-01

Part 1 About your firm in general

These questions are to give us some general information about you and your firm and your business on the whole. Please include your telephone number only if you are happy to answer clarification questions.

If your firm is made up of more than one separate business entity, and it is too difficult to provide aggregate responses of all entities, please either answer one questionnaire per entity, or choose only the entity that makes most use of the R&D Tax Concession. *If exact data is not available, please provide your best estimate.*

1.1 Your Australian Company Number (ACN):	
1.2 Your name:	
1.3 Your current position within the company:	
1.4 Your contact telephone number (optional):	
1.5 Your company name:	
1.6 Is your company public or private?	☐ Public ☐ Private
1.7 What proportion of your company is foreign owned?	%
1.8 In which year did your company begin operations in Australia?	
1.9 What was the turnover (total sales) of your firm in 2001-02?	$
1.10 What percentage of your turnover is due to export sales?	%
1.11 What percentage of your sales go to - household customers? – business customers? – other? Please specify	 % % %
1.12 What percentage of your labour force is skilled (that is, holds tertiary qualifications or equivalent skill level)?	%

Part 2 Your Research & Development

We need to know some details about your R&D and what factors help influence the level of your investment in R&D. *If exact data is not available please provide your best estimate.*

2.1 What is preventing your firm from doing more R&D? *Please rate the importance of the constraint from 0 (being the lowest) to 10 (being highest)?*

Factors	*Rating (0–10)*
Opportunity and motivation	
a) Lack of technological opportunities	
b) Lack of market opportunities	
c) R&D not profitable:	
▪ - more profitable overseas	
▪ - too risky	
▪ - competitors will catch up too quickly	
▪ - low expected returns	
Resource availability	
d) Capital and financing	
e) Skilled labour	
f) Collaborators	
g) Specialised technical/laboratory equipment	
Government constraints	
h) Company tax rate	
i) Regulations (OH&S, environmental)	
j) Labour market controls	
k) Cost of patents	
l) Inadequacy of intellectual property protection	
m) Other government constraints, please specify	

2.2 The following question asks about your current break up of R&D spending, and how much your R&D spending would change when the cost of various resources changed. *Please provide your best estimate.*

		If the cost of the following resources decreased by 20%, how much would you change your use of that resource?					
Resource costs of:		*Please indicate current % of R&D spending*	*Increase by 0-5%*	*Increase by 6– Increase by 11–15%*	*Increase by 16–25%*	*Increase by 26–50%*	*Increase by >50%*
▪ rent, building or plant/machinery	%	☐	☐	☐	☐	☐	☐
▪ skilled labour	%	☐	☐	☐	☐	☐	☐
▪ general inputs and materials	%	☐	☐	☐	☐	☐	☐
▪ specialised technical or laboratory equipment	%	☐	☐	☐	☐	☐	☐
▪ collaboration	%	☐	☐	☐	☐	☐	☐
▪ contracted out R&D	%	☐	☐	☐	☐	☐	☐
▪ other, please specify	%	☐	☐	☐	☐	☐	☐
Total	100%						

Part 2 Your Research & Development *(continued)*

2.3 What was your total R&D expenditure in 2001-02? $

If your company has been conducting research in Australia since 1996, please answer Q2.4. Otherwise, please go straight to Q2.5.

2.4 In 1996 the Government introduced several reforms to the R&D tax concession, including reducing the rate from 150 to 125 per cent. This question is designed to determine the influence of those reforms on R&D.

a) What was your R&D spending in 1995-96? *$*

b) How much has your R&D spending changed from 1995-96 to 2001-02? +$ -$

c) Rate the importance of the following issues on your decision to change the level of R&D? Please indicate also the direction of the impact.	*Increase or decrease? (+/-)*	*Rate each impact from 0 to 10 on how important they have been*
Changes to the rate of tax concession		
Other changes to the tax concession (for example the abolition of syndication)		
Change in technological opportunities		
Change in market opportunities		
Change in other government policies		
Change in availability of labour, collaborators & equipment		
Change in profitability of R&D		
Other (please specify)		

2.5 Hypothetically, if the tax concession was increased by 25%, how would that influence the amount of R&D you would do? (*as a percentage of your current R&D spending*)

☐ 0% ☐ 0–5% ☐ 5–10% ☐ 10–15% ☐ 15–20% ☐ 20–30% ☐ >30%

2.6 If management were to lower the threshold required rate of return by 20 per cent then approximately how much more R&D do you think you would do? %

2.7 How much (if any) of your R&D spending was conducted internationally (as a percentage of total R&D)? %

2.8 If some of your R&D was conducted internationally, in which countries was it conducted?

2.9 If you are doing R&D internationally, what issues are preventing you from doing that R&D in Australia? Please tick the appropriate box, and give details.

Issues		*Please specify*
Tax reasons	☐	
Skill availability	☐	
Availability of R&D infrastructure	☐	
Need to be close to clients	☐	
Critical mass	☐	
Political and security issues	☐	
Other	☐	

2.10 Do you make use of the tax offset? Yes ☐No ☐

If No, why not?

Part 3 Your R&D outputs & outcomes

We also require information about what the outputs and outcomes are from your company's R&D investments over the past 4 years. *If exact data is not available, please provide your best estimate.*

3.1 Of your R&D that was eligible for the 125% tax concession, what percentage was also eligible for the 175% premium tax concession? *Please provide your best estimate.*

Year	*175% premium tax concession*
2001-02	%
2002-03	%

3.2 What percentage of your R&D is highly novel or develops a platform technology (that is, technology that might be used to spur innovations in other industries or applications)? %

3.3 Please indicate the proportion of your R&D projects that are a technical success, or the average probability of success of your projects. Also, please indicate the average time necessary from the concept to prototype and the average cost of an R&D project to the prototype stage.

	Likelihood of success	*Time taken*	*Total cost*
R&D (technical aspect)	%	years	$

3.4 Assuming you have achieved technical success, please indicate the proportion of your R&D projects (or average probability of success of your projects) that go on to be a commercial success? Also, please indicate the average time necessary from prototype to commercialisation and the average cost of commercialisation.

	Likelihood of success	*Time taken*	*Total cost*
Commercialisation	%	years	$

3.5 For every dollar you invest in R&D and commercialisation (from questions 3.4 and 3.5) what accumulated financial benefit do you expect for an average successful project over 20 years. Breakeven would be 1:1. Investing 1 dollar at 12% compound interest would give you 10:1 after 20 years.

Benefit–cost ratio	<1:1	1:1	2:1	5:1	10:1	15:1	20:1	>20:1
Compounding rate of return	<0%	0%	4%	8%	12%	14%	16%	>16%
Please tick	☐	☐	☐	☐	☐	☐	☐	☐

3.6 What is the minimum benefit to cost ratio for a 20 year project that your company would require to go ahead with the project? Benefit to cost ratio: :1

3.7 On average, how long after commercialisation until your competitors catch up with you (that is, you lose your competitive edge) or the benefit of your R&D is otherwise made less relevant (for instance, through your own additional R&D)? years

3.8 On average, how many patents do you apply for each year?

Part 3 Your R&D outputs & outcomes *(continued)*

3.9 As a result of your R&D, which of the following outcomes are significant for your business? *Please provide a rating from 0 (lowest) up to 10 (highest).*

New intellectual property	*Rating (0–10)*
a) New product for sale	
b) Better quality product for sale	
c) Reduced costs due to process improvements	
d) New intellectual property	
e) Increased opportunities for further profitable business ventures	
f) Reduction in materials used or waste in production	
g) Improving corporate image (meeting social goals)	
h) Meeting government requirements (OH&S, environment etc).	
i) Other – *please specify*	

3.10 How much higher do you think your domestic sales, export sales, turnover and profit will be in 5 years time from the R&D you conduct in a typical year. In the case of 'cost of production', how much lower do you think it will be? *We understand that exact answers will not be possible – please supply your best estimates.*

	0-5%	*6-10%*	*11-15%*	*16-20%*	*21-25%*	*> 25%*
a) Domestic sales (quantity)	☐	☐	☐	☐	☐	☐ *Specify*
b) Export sales (quantity)	☐	☐	☐	☐	☐	☐ *Specify*
c) Turnover (value)	☐	☐	☐	☐	☐	☐ *Specify*
d) Profit	☐	☐	☐	☐	☐	☐ *Specify*
e) Cost of production	☐	☐	☐	☐	☐	☐ *Specify*

3.11 Hypothetically, if you could have costlessly increased your R&D activity 5 years ago by 50%, please indicate how much higher your think your domestic sales, export sales, turnover and profit might be now. In the case of 'cost of production', how much lower do you think it will be. *We understand that exact answers will not be possible – please supply your best estimates*

	0-5%	*6-10%*	*11-15%*	*16-20%*	*21-25%*	*> 25%*
a) Domestic sales (quantity)	☐	☐	☐	☐	☐	☐ *Specify*
b) Export sales (quantity)	☐	☐	☐	☐	☐	☐ *Specify*
c) Turnover (value)	☐	☐	☐	☐	☐	☐ *Specify*
d) Profit	☐	☐	☐	☐	☐	☐ *Specify*
e) Cost of production	☐	☐	☐	☐	☐	☐ *Specify*

3.12 For every dollar of benefit you receive from your R&D, what benefit do you think your customers receive? $

Part 4 Other issues

We would also like to understand any other costs or issues you may have encountered with the R&D tax concession program. *If exact data is not available, please provide your best estimate.*

- 4.1 What were the compliance costs incurred (including a value of your time taken) by your company in applying for the tax concession? $ /year
- 4.2 Has your R&D built on R&D done previously by other firms in the past five years (whether competitors or firms in another industry)? Yes ☐ No ☐
  If yes, how important has that R&D been on a scale of 1 to 10?
- 4.3 If you answered yes to 4.2, how did you get access to the previous R&D?
- ☐ Purchased intellectual property ☐ Staff movements ☐ R&D wasn't protected ☐ Reverse engineered ☐ Other please specify
- 4.4 Is your R&D protected from being copied by any of the following: Rate each factor from 0 to 10 on how important they are
  - Patent? No ☐ Yes ☐
  - Other IP rights eg licensing, plant variety rights? No ☐ Yes ☐
  - Ownership or rights to other essential inputs? No ☐ Yes ☐
  - Ownership or rights to key technology input? No ☐ Yes ☐
  - Complexity of production? No ☐ Yes ☐
  - Dedicated client base? No ☐ Yes ☐
  - Quick speed to market? No ☐ Yes ☐
  - Other? *Please specify*

4.5 Please indicate if there have been any other significant spillover economic impacts or innovations from your R&D that have impacted on your firm, other firms in your industry and firms outside your industry. Indicate the size of the effect using a rating from 0 (lowest) to 10 (highest).

Area of impact	*Impact (0-10) on:* own firm	firms in industry	other industries
a) Reduced occupational health & safety (OHS) hazard			
b) Reduced pollution			
c) Reduced company/industry risk			
d) Increased skills of employees			
e) Development of a new or improved platform technology			
f) Other impacts, such as helping to create a necessary critical mass for a start up industry or new spinoff companies. *Please specify*			

4.6 Do you have any further comments on the tax concession or any suggestions on how the tax concession could be improved?

4.7 Please indicate how long it took you to complete this survey? hours

Supplementary section

Thank you for completing the main part of this questionnaire. If you have some more time, your responses to these supplementary questions will be appreciated, though it is not essential for the completion of this review. Not all questions will be relevant to all firms, but please complete any questions relevant for your firm.

S.1 Which of the following government programs has your company used in the past five years and which do you currently use?

Organisation	*Have previously used*	*Currently use*
R&D Start grant	☐	☐
R&D Start loan	☐	☐
R&D Tax Concession	☐	☐
Innovation Investment Fund	☐	☐
State Government support	☐	☐
Export Market Development Grant	☐	☐
Austrade loan	☐	☐
Other (please specify)		☐

S.2 How much of your R&D spending comes from the following sources (as a percentage of total R&D spending)? *Please provide your best estimate*

Funding	*Have used as a source of funding (please tick)*	*Percentage of total R&D (should sum to 100%)*
From retained earnings	☐	%
From borrowings	☐	%
Government programs	☐	%
Funds raised from investors	☐	%
Other (please specify)		%

S.3 Have there been any projects undertaken by your firm in which consideration of the tax concession played a part in deciding whether it should go ahead or not?

Consideration	Please tick
a) No direct consideration	☐ Go to S.5
b) Considered tax concession, but didn't change decision	☐ Go to S.5
c) Considered tax concession and undertook research because of it	☐ Please answer S.4 if possible

S.4 If you answered C to question S.3, please discuss. If possible, please include the value of the project(s), financial return of the project(s) and nature of the project(s).

S.5 If you had more funds for R&D, what would you spend them on? For every additional dollar you spent, what percentage of that spending would go to each option?

Expenditure of funds	*Please indicate by ticking the box*		
Extending current projects	☐	How much?	%
Purchase new technology	☐	How much?	%
Increase number of staff	☐	How much?	%
Improve other inputs (buildings, machinery, materials, etc.)	☐	How much?	%
New projects	☐	How much?	%
Other, *please specify*	☐	How much?	%
		Total = 100%	

S.6 Do you think that you are currently spending the right amount on R&D as opposed to other costs? Yes ☐ No ☐

S.7 If your company increased spending in R&D, but decreased spending on other areas of business (for example, less employees, a smaller building, less machinery, etc.), in 5 years, what would happen to your:

- turnover? %
- profit? %

S.8 If profits increased in S.7, what is preventing you from adjusting your business plan accordingly?

S.9 The following questions require you to estimate how much your sales and profit would change if you had to increase the price of all your products, while the quality of your products and the prices of your competitors remained unchanged.

	Increase	*Little change*	*Decrease by 1–15%*	*Decrease by 15–25%*	*Decrease by 26–50%*	*Decrease by >50%*	*Wouldn't sell anything*
a) If you had to increase your prices by 10%, what would it do to your quantity of sales?	☐	☐	☐	☐	☐	☐	☐
b) What would it do to your profit?	☐	☐	☐	☐	☐	☐	☐
c) If you had to increase your prices by 40%, what would it do to your quantity of sales?	☐	☐	☐	☐	☐	☐	☐
d) What would it do to your profit?	☐	☐	☐	☐	☐	☐	☐

S.10 If some of your R&D was contracted out, to whom and how much (as a percentage of total R&D spending)?

Organisation	*Percentage*
CSIRO	%
CRCs	%
Universities	%
Other businesses	%
Other research agencies	%
Other	% *Please specify*

S.11 What criteria do you use when deciding whether or not to proceed with an R&D project?

	Please indicate by ticking the appropriate box
a) Required rate of return	☐
b) Minimum payback period	☐
c) Other	☐ *Please specify*
d) No formal criteria	☐

S.12 In your opinion, how much of the R&D benefit you derive comes at the expense of your domestic competitors (as a percentage of you benefit)? %

S.13 How much of your R&D is dedicated to decreasing your costs of business (as opposed to other goals such as improving the quality of products, new products, meeting government regulations, improving your corporate image etc)? %

S.14 Please indicate how long it took you to complete the entire survey, including the supplementary section? hours

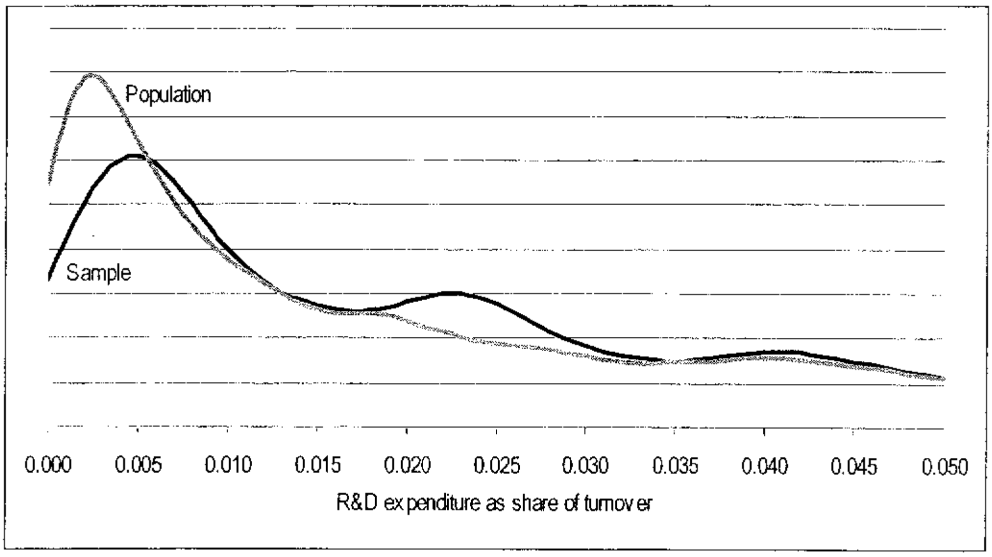
D Additional survey information

The following charts provide some additional information to that provided in chapter 3.

Representativeness of the survey results

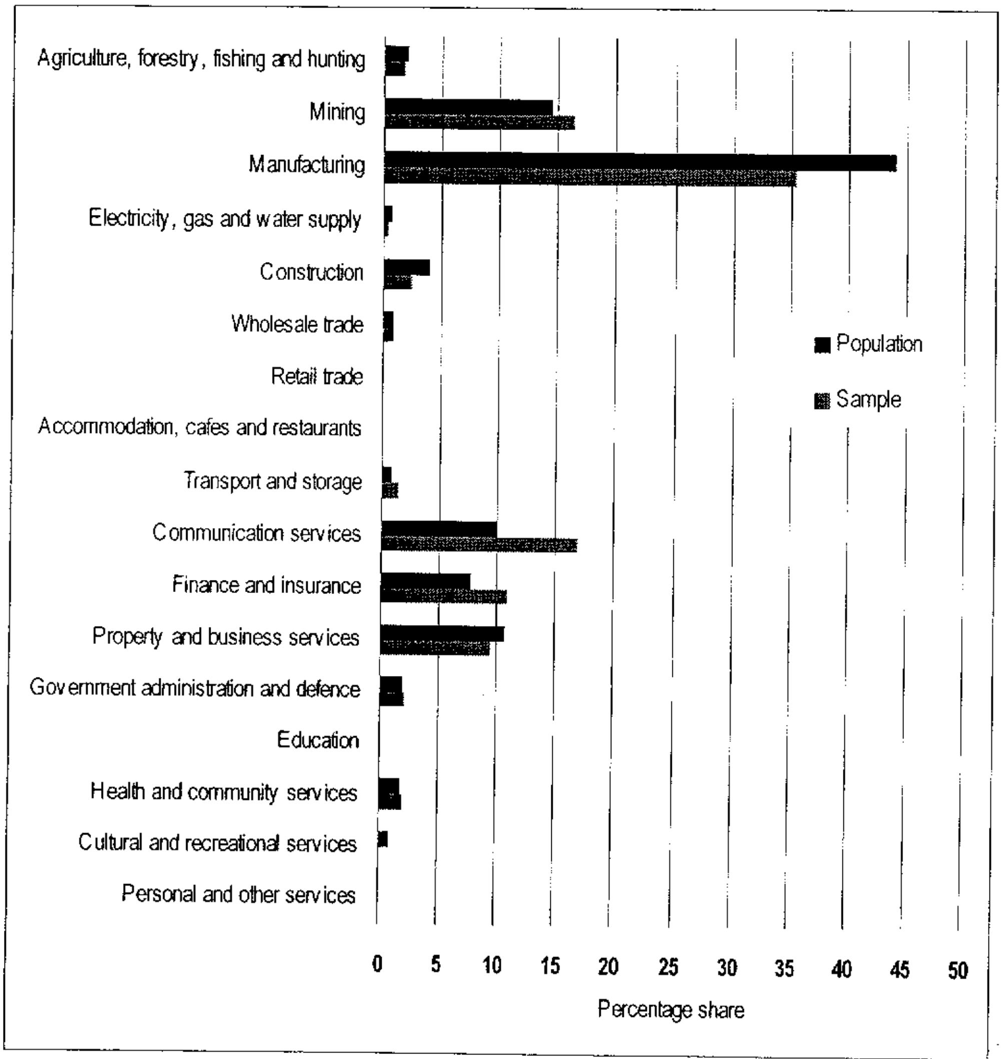
As indicated in chapter 3, the survey provides a reasonable representation of the population. Chart D.1 indicates the distribution of the R&D intensity (ratio of R&D expenditure to turnover) and chart D.2 shows a comparison between the population and sample sectoral distribution.

D.1 **Distribution of ratio of R&D expenditure to turnover**



Data source: Survey results.

D.2 Comparison between population and sample sectoral distribution



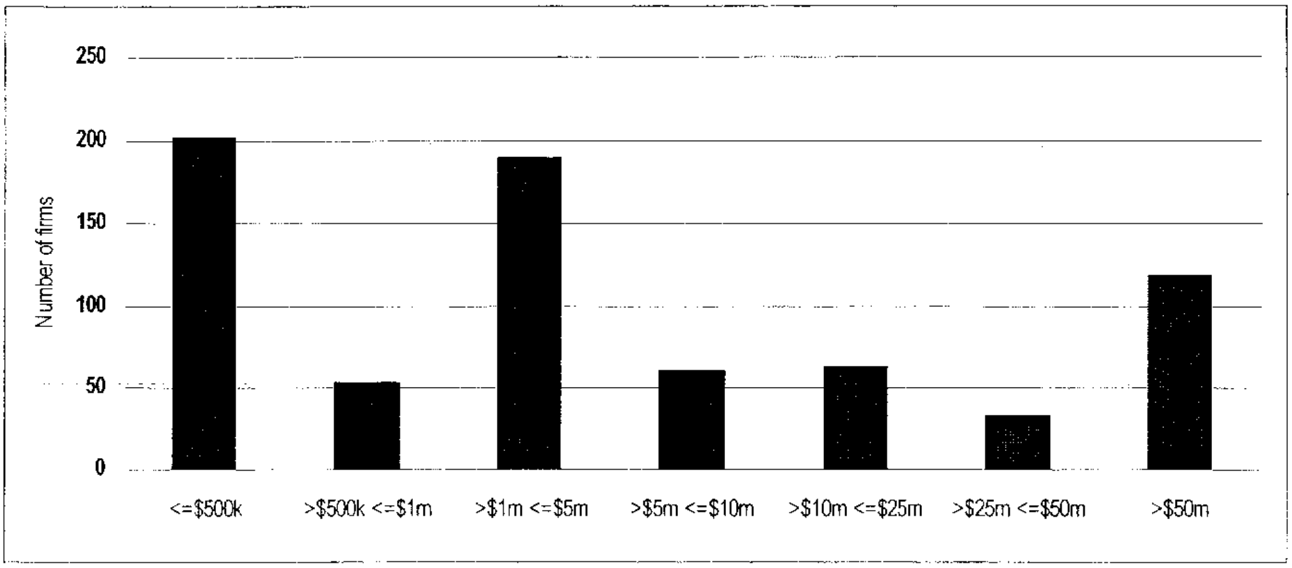
Data source: Survey results.

Different definitions of small, medium and large firms

As noted in chapter 3, for the purposes of the survey, the sample was stratified by R&D expenditure. Firms with more than $1 million spending on R&D are large, firms with more than $500,000 but less than $1 million are medium and the remainder are small. However, for the purposes of analysis in chapter 3, we determined firm size by the number of employees.

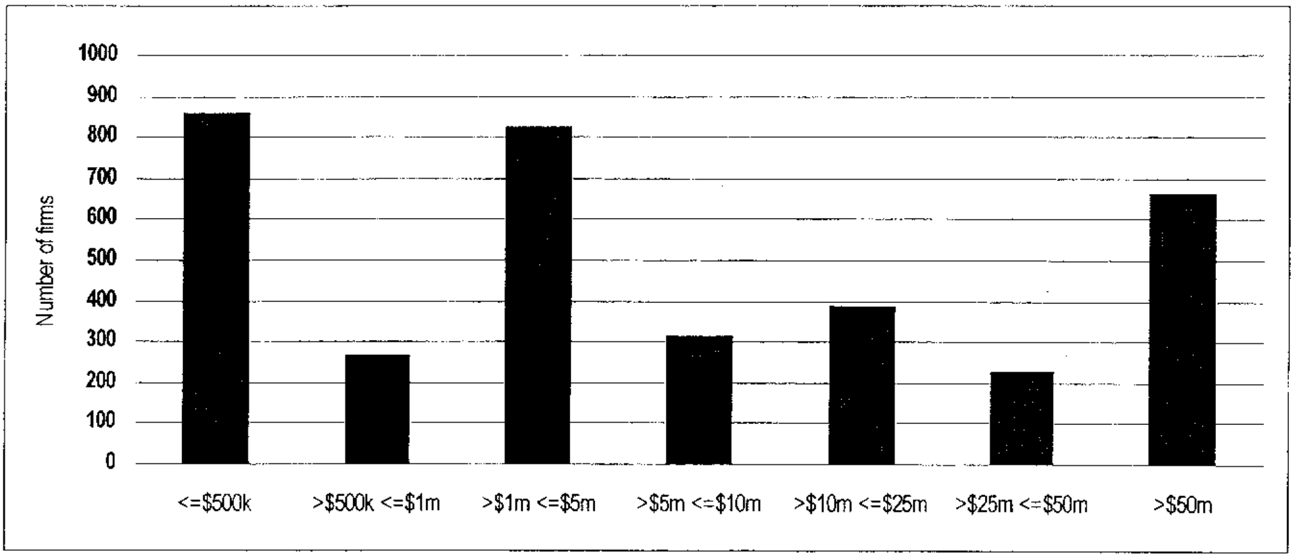
It is also possible to split firm size by turnover. The below charts provide some information on the survey data with firm size classified by turnover. Charts D.3 and D.4 represent the sample and population number of firms, with seven different firm size classifications based on turnover. The two

D.3 **Firms by turnover range: sample**



Data source: CIE survey results.

D.4 **Firms by turnover range: population**

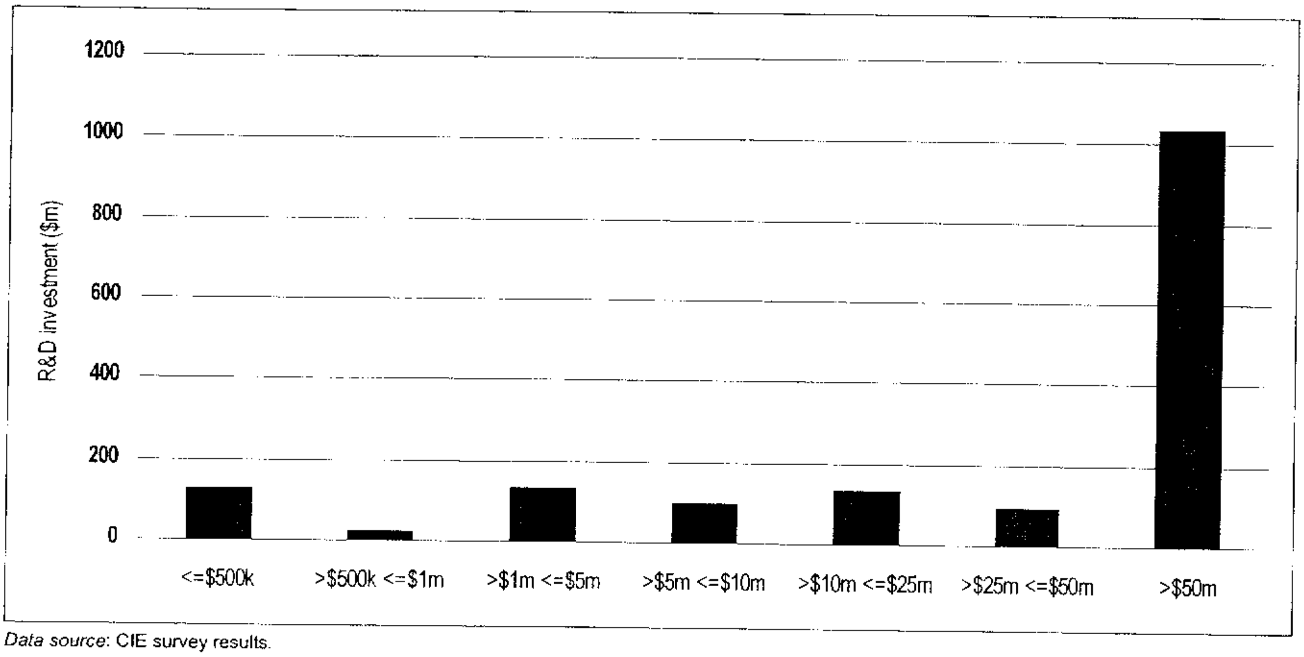


Data source: AusIndustry (2003).

charts provide further evidence that the sample is a good representation of the population.

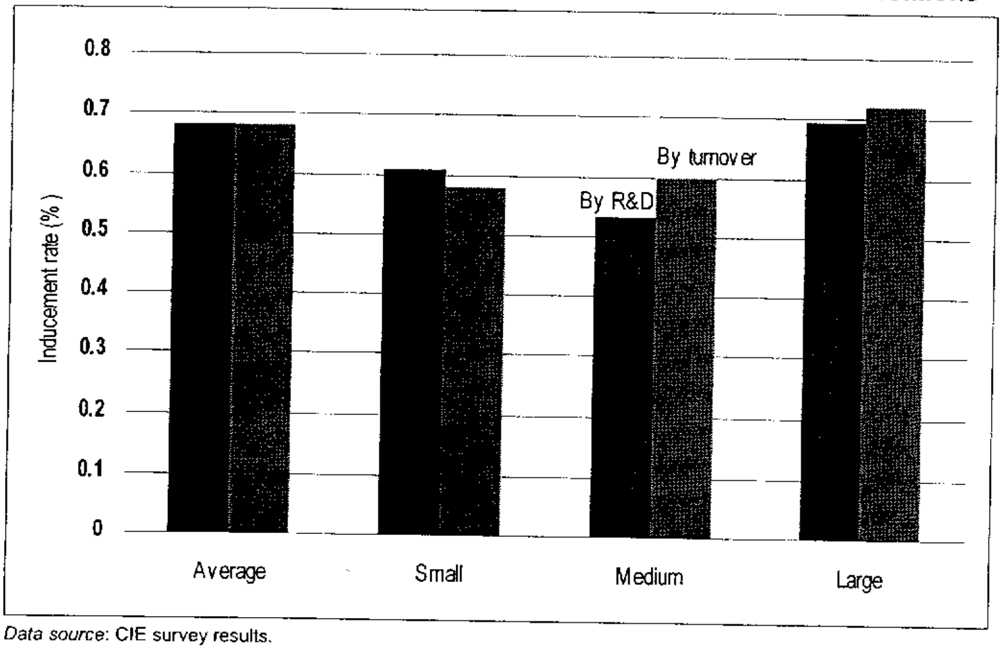
Chart D.5 shows the amount of R&D investment undertaken by seven different firms sizes classified by turnover. While the different firm classifications are not comparable, it is clear that large firms (here classified as firms with a turnover greater than $50 million) continue to make up a considerable majority of all R&D investment undertaken.

D.5 **R&D spending by firm turnover**



Data source: CIE survey results.

D.6 **Comparing inducement rates between different firm size classifications**



Data source: CIE survey results.

Finally, chart D.6 shows a comparison between small, medium, large and average inducement rates using both the R&D classification of firm size (as used in chapter 3) and the turnover classification of firm size. Small firms under the turnover classification include all firms with turnovers less than $5 million, while medium size firms have turnovers between $5 million and $50 million.

The different firm classification has no impact on the weighted average level of inducement, and it has a minor impact on the comparative levels of inducement for different firm sizes. These conclusions show that the results reported in chapter 3, and the inducement calculations in chapter 5, are not sensitive to different classifications of firm size.

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