Innovation Management in the Australian Government: Cost and Benefit of R&D Tax Concession Program

Yong-Eun Moon*, Joseph Yoon**

목 차

Key Words:Australia, innovation, R&D, Government policy, Tax Concession

Abstract

In industrialised countries, innovation is a key source of economic growth. Research is a key driver of technological innovation and involves the process of systematic investigation and/or experimentation to discover new knowledge. The Governments' industry innovation policy supports a business focus on Research and Development (R&D) through a range of programs in order to achieve these aims.

The Innovation Statement (DISR 2000, 20010, launched by the Australian Prime Minister?in January 2001, commits an additional $3 billion over five years to encourage and support innovation. The Australian Government aims to?build world competitive firms and strong research capability in industry to strengthen Australia's international competitiveness and increase national prosperity.?It develops policies and programs to enhance investment in innovation.

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 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 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. In this sense, this paper looks at the appropriateness, effectiveness and efficiency of the R&D tax concession with costs and benefits analysis.

* yemoon@silla.ac.kr / Silla University, San1-1 Kwaebop-dong, Sasang-gu, 617-736, Busan, Korea

** Joseph.Yoon@industry.gov.au / Australian Government, Department of Industry, Tourism and Resources GPO Box 9839, Canberra, 2601, Australia

Ⅰ. Introduction

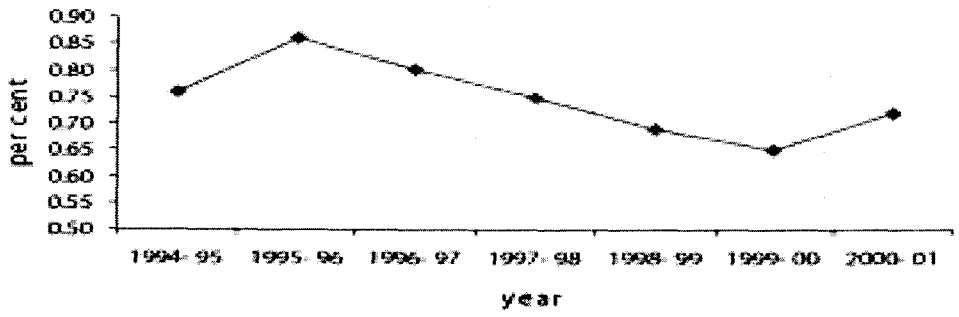
Innovation – developing skills, generating new ideas through research, and turning them into commercial success– is key to Australia's future prosperity. Innovation is not only the province of new or high tech industries, but also essential to the future of many of the traditional sectors such as agriculture, manufacturing and mining.

Backing Australia's Ability (Australian Government 2002; Yoon 2003a,2003b, 2003c, 2003d) outlines the Government's strategy to encourage and support innovation and enhance Australia's international competitiveness, economic prosperity and social wellbeing. Government has two central roles – firstly to provide the best possible economic, tax and educational framework, and secondly to provide targeted direct support in areas where private sector funding is not appropriate or available. *Backing Australia's Ability* reinforces the Government's long standing support for these roles. It reinvigorates the research base, and provides targeted support to drive commercial outcomes. Each initiative addresses a priority area and is designed to have maximum impact while being fiscally responsible.

A key aim of the strategy is to strengthen Australia's research capability, to ensure the flow of new ideas which underpin innovation, and to create critical mass in leading research fields. The strategy provides significant new investment in these areas including additional funding and incentives to ensure Australia's research base–the backbone of the innovation system–remains strong and internationally competitive.

Figure 1 shows business expenditure on Research and Development (BERD) in Australia as a percentage of Gross Domestic Product (GDP) over time. On this measure, Australia's business R&D performance declined from 1995–96 to 1999–2000.

Figure 1. Australia's BERD as a percentage of GDP



Source: Australian Bureau of Statistics data (2003)

However, all major industry sectors recorded an increase in R&D expenditure in 2000-01 with *Backing Australia's Ability* program.

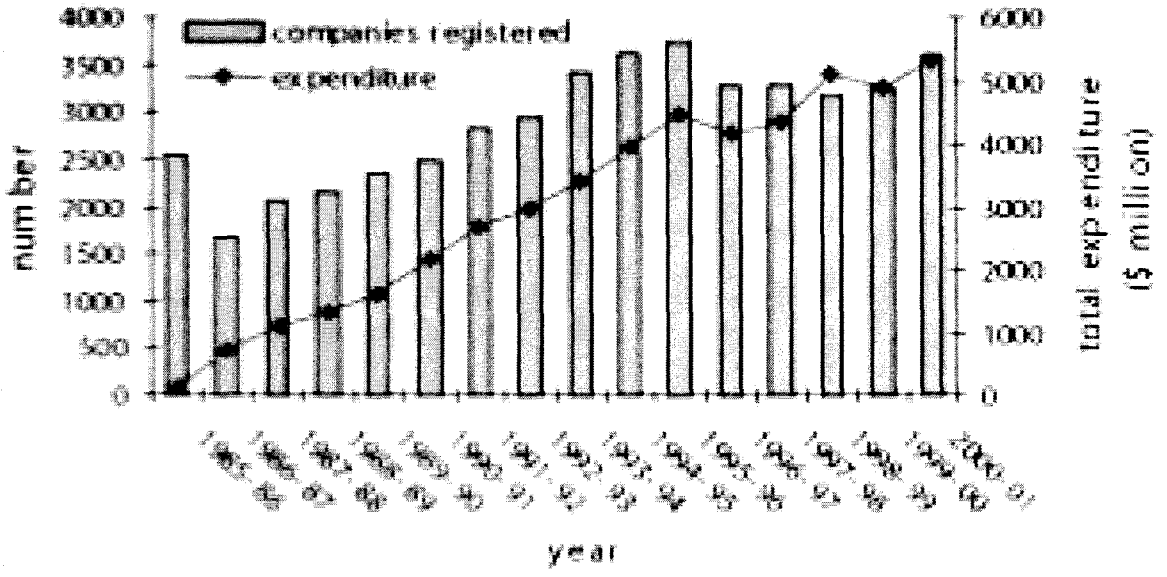
In this sense, the Government's incentives to stimulate increased business investment in R&D have been effective. In particular, new tax concessions to encourage companies to increase R&D efforts have had very positive outcome. Sixteen OECD countries, including Australia, provide additional tax incentives to business in the form of R&D tax credits and allowances to encourage investment in R&D. Many studies have shown that R&D tax incentives are an important method of stimulating R&D activity (OECD, 2002).

Ⅱ. The Overview of 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 Industry Research & Development Board's 2001-02 Annual Report (AusIndustry, 2003a), the main objectives of the tax concession are:

* increase investment in R&D activities;
* to encourage the development of innovative products, processes and services;
* promote technological advancement through a focus on innovation and high

Figure 2. Registration applications 1985-86 to 2000-01



Source: AusIndustry

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 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 (AusIndustry, 2003b), 93 per cent of R&D tax concession recipients are satisfied with the overall delivery of the tax concession scheme.

R&D registrations and associated reported expenditure increased steadily up to 1996. Due to changes in the concessional rate and the removal of access to syndication in 1996, there was a fall in registrations for a few years but there have been increases after introducing 175% and offset program as in Figure 2.

2.1. Eligibility of the R&D Tax Concession

To be eligible for the 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[1]);
* 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[2] (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[3].

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. 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

1) For RRA, see http://www.ausindustry.gov.au
2) For R&D Plan, see http://www.ausindustry.gov.au
3) For ITAA, see http://s http://scaleplus.law.gov.au/html/pasteact/2/3036/0/PA004290.htm caleplus.law.gov.au/html/pasteact/2/3036/0/PA004290.htm

certain activities will be eligible for the tax concession.

2.2. Administration of the R&D Tax Concession

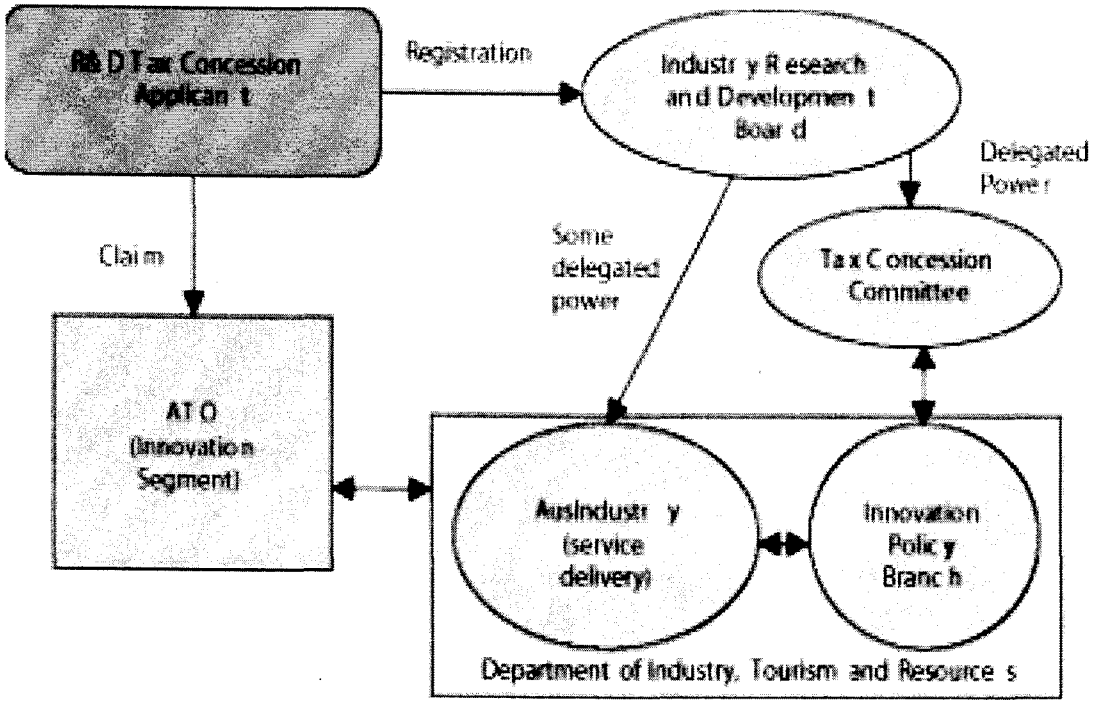
A company cannot claim the R&D tax concession unless it is registered with the Industry Research and Development (IR&D) Board. To be registered a company must lodge an application form with the Board within 10 months of the end of the year of income in which the qualifying expenditure on R&D activities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

The key administrative bodies, their responsibilities and relationship with Concession claimants are summarised in Figure 3.

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

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 AusIndustry to determine whether R&D activities are eligible and also provides advice and

Figure 3. R&D Tax Concession administrative framework



Source: Australian National Audit Office Audit report (2003)

assistance to taxpayers on R&D expenditure issues.

2.3. Operation of the R&D Tax Concession

The 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[4].

In addition to this first round effect (7.5 per cent reduction in R&D costs) there may be reasons to think that the 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 side, 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 most 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.[5] Further, the methodology used

4) Guide to the R&D Tax Concession is the best reference for the information, see www.ausindustry.gov.au.

5) 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.

6) This is based on the internal paper.

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 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[6].

2.4. Changes to the R&D Tax Concession

The 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 additinoal investment in R&D;
* The introduction of an R&D Tax Offset (also referred to as a Rebate) for small companies 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 which 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

Table 1. Evolution of the 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 tax concession. [b] 175 per cent premium tax concession.

Source: AusIndustry

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

2.5 Previous review of the 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).

2000 DISR-Allens report

The most recent review of the tax concession 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 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 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.

Ⅲ. Costs of the 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.

3.1 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 (TES).

The 2002 TES estimates that the total cost of the R&D Tax Concession (including the 125-per-cent 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.

3.2 Economic efficiency cost

All government programs need to be funded, even tax expenditures. 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. In this study we use a range of efficiency costs, from 20 per cent to 40 per cent, with a mid-point of 30 per cent.

3.3 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 tax concession, ACG (2000) used DITR advice to conclude that the total estimated cost of administering the 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.

3.4 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 costs 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 tax offset). While the 125-per-cent 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 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 tax concession.

3.5 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.

3.6 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.

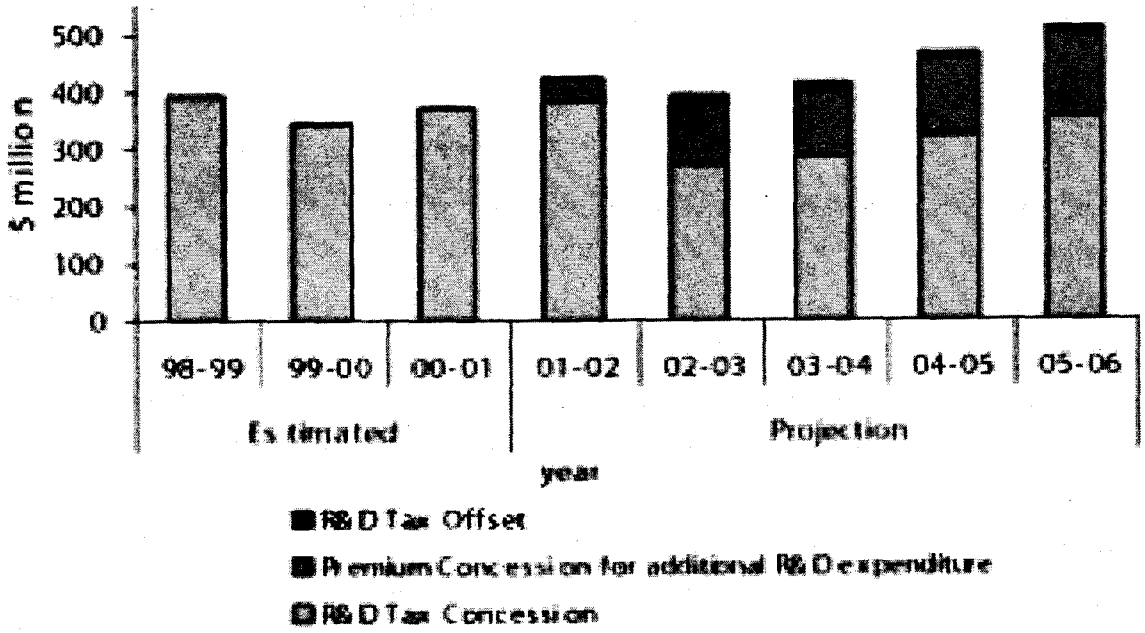
It should be noted that the budget cost of $280 million represents a transfer of funds from taxpayers to researchers. To the degree that researchers appropriate the funds without changing their R&D behaviour, this is a direct funds transfer and the cost to the government will be matched by the benefit 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

Table 2. Cost of the 125 per cent R&D Tax Concession

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).

Figure 4. Estimated cost of R&D Tax Concession



Source: Tax Expenditure Statement, 2002

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. The following chapter will consider the inducement rate and the spillover rate in more detail.

Ⅳ. Benefits of the R&D Tax Concession Programs

4.1 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 $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.

In 1997 Lattimore calculated that the 125 per cent 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[7].

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

7) 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.

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 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 elasticity of final products and non-linear supply elasticity for R&D inputs [8].

Table 3 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

Table 3. 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.

8) Based on internal evaluation.

9) 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.

$500,000 and $1-million) and small R&D firms (less than $500,000)[9]. Below is a brief discussion of each methodology.

4.2 Private benefits

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.

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 the 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.

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 and also through flow-ons and spillover benefits.

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.

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– However, there is insufficient evidence of this to conclude that it is 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.

4.3 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. 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 do 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 flowon 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:

* 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.

Table 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	Aust	552	

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 4.

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.

4.4 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 this 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 was 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.

V. Analysis and Conclusion

5.1 Benefit-cost analysis

The benefit-cost ratio for each of 84 different scenarios was analysed 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).

5.2 The 175 per cent premium tax concession and 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

Table 5. Benefit to cost ratios by spillover and 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										
Inducement rates	0.40	0.60	0.65	0.71	0.76	0.82	0.87	0.93	0.98			1.58	2.07
	0.50	0.61	0.68	0.75	0.82	0.88	0.95				1.22	1.84	2.45
	0.60	0.63	0.71	0.79	0.87	0.95				1.28	1.36	2.10	2.83
	0.70	0.64	0.73	0.83	0.93			1.21	1.31	1.40	1.50	2.36	3.21
	0.80	0.65	0.76	0.87	0.98			1.31	1.42	1.52	1.63	2.62	3.59
	0.90	0.67	0.79	0.91			1.28	1.40	1.52	1.65	1.77	2.88	3.97
	1.00	0.68	0.82	0.95		1.22	1.36	1.50	1.63	1.77	1.91	3.14	4.35

Source : CIE model.

the marginal impact of these elements may be of value in several years when more data is available.

The total cost of the tax offset is estimated at around $10-million. Because of the greater flexibility of the 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.

5.3 Conclusions

This paper 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 regards it is *appropriate* to consider the use of the 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.

As a conclusion, the R&D Tax Concession is an appropriate and effective policy. 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 Tax Offset given that they have been in operation for one year only. A review of these elements might be appropriate in several years and might give more accurate analysis on R&D Tax Concession.

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