THE UNIVERSITY OF MELBOURNE

FACULTY OF BUSINESS & ECONOMICS

Melbourne Institute Working Paper Series

Working Paper No. 24/11

The Design of R&D Support Schemes for Industry

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Melbourne Institute Working Paper No. 24/11

ISSN 1328-4991 (Print)

ISSN 1447-5863 (Online)

ISBN 978-0-7340-4257-6

November 2011

* Thanks to Rob Bryant and Phil Ruthven for permission to use IBISWorld Business Information, Evan Lloyd for research assistance and Deborah Cobb-Clark and Jonathan Chew for comments. Funding for this research was provided by the Commonwealth Department of Climate Change but do not represent the opinions and views of the Department.

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Abstract

Scant discussion exists in the literature about the relative design merits of various R&D schemes and most authors treat program design as a black box. In this paper, we assess the design features of three major forms of R&D support: entitlement schemes, competitive schemes and industry R&D boards. We use a combination of evidence to comment on how well these schemes perform in terms of: firm engagement (how does the scheme recruit business interest?); project selection (what criteria are used and who selects the projects?); payment structure (how is financial support structured?) and administrative costs (what is the burden?).

JEL classification: L52, O25, O32, O38

Keywords: R&D policy, tax concession, government grants, R&D boards, R&D support

1. Introduction

What are the attributes of effective R&D support program design? While much has been written on the case for providing public support for business R&D,[1] all most universally, papers stop well short of advocating how this should be done. The implicit message is that all support is all equally effective, however most people, especially program participants and managers, are all too aware that some schemes are more effective than others. The omission of critical evaluation in the scholarly literature is not surprising given the difficulty many independent researchers have gaining access to the names and details of program participants and, moreover, *potential* participants.

In this paper, we make a modest step towards a better understanding of effective design of R&D support policy. Our approach is to compare and contrast programs and program attributes, taking into account the perspectives of administrators, program participants and potential participants. Our findings are based on a review of international and Australian literature, and information collected via 138 interviews with research managers from Australian firms, program administrators and private sector intermediaries. Specifically we conducted face-to-face interviews with 18 with government program managers and private sector intermediaries[2] as well as a telephone survey of 59 R&D active firms (potential applicants), and a further 61 successful competitive grant recipients.[3] Details of the survey design and responses are presented in the appendix.

We begin this paper with a brief summary of the case for public support of business R&D and then proceed to discuss several main types of R&D support. The following section introduces the four attributes of program design and identifies how these are manifest in

[1] For a recent review see Hall, Mairesse and Mohnen (2010). While there exist a number of comprehensive studies of the effectiveness of Australian R&D tax incentives (Bureau of Industry Economics 1993; Thomson 2010), analysis of other modes of R&D support have generally been limited to case studies, descriptive tabulations of gross outcomes or audits for internal budgeting purposes.

[2] By intermediaries we mean private companies whose principal function is to assist R&D active firms benefit from government R&D support.

[3] Government grant administrators declined to provide details of unsuccessful grant recipients.

different types of schemes. The final section summaries and gives some concluding comments.

2. Policy rationale: spillovers and risk

There are several reasons why the socially desirable level of R&D investment is not met in a competitive market. The most common argument relates to the inability of firms to capture enough benefit from their innovative endeavours (i.e. suboptimal excludability). To some extent, intellectual property rights, trade secrecy, and strategic use of complementary assets can facilitate excludability and thereby aide the appropriation of innovation profits. However, a strategy (policy) focused exclusively on 'internalizing' these benefits has two flaws. First, raising appropriation can be impractical since R&D can have unobservable and far reaching benefits. Secondly, charging a price for a 'good' that has zero (or negligible) social cost results in static deadweight loss and can have a negative effect on sequential technological progress.

A further reason for public intervention in the innovation 'market' relate to the high degree of risk inherent in R&D investment. Economists have long differentiated between actuarial risk, where outcomes conform to some known probability distribution; and, uncertain risk about which no information about the distribution of possible outcomes is available (Knight 1921; Keynes 1936). Where markets are sufficiently complete, actuarial risk can be reduced via aggregation though in practice this only covers a small range of activities (via for example insurance schemes). On the other hand, uncertain risk, can only be transferred between parties – not reduced. However, if the marginal cost of bearing risk increases with the amount of risk held, the total *cost* of a given level of uncertain risk can be reduced by spreading it across the many parties (Arrow and Lind 1970). There is a considerable body of empirical evidence that capital markets can fail to effectively service some high risk R&D activities (Hall 2005). Government funding effectively represents spreading the risk of R&D across the entire tax base.

A considerable weight of international evidence finds that the social rate of return to R&D is considerably higher than the social discount rate (see Jones 1998; Frantzen 2000; Lederman and Moloney 2003; Hall, Mairesse and Mohnen 2010). This suggests that

investment in R&D is still below the socially optimal level, even given the spectrum of policies already in place.

3. Types of R&D schemes

Innovation policies to overcome these market failures include competitive grants given to firms and universities, procurement, intramural R&D (such as funding to CSIRO), and the state enforcement of monopoly intellectual property rights. In this paper we focus on subsidies provided to private firms. We consider three main types of R&D support to the private sector: entitlement schemes, competitive grant schemes, industry R&D boards.

COMPETITIVE SCHEMES: Under competitive schemes, firms intending to make eligible expenditures 'compete' for a finite pool of funding according to a stated merit criteria. The merit criteria are determined at the policy level, although administrators and selection committees generally have some degree of discretion. Ranking is usually determined by a peak body such as a bureaucratic or scientific committee. Most competitive schemes are for grants but loans can also be allocated this way.

ENTITLEMENT SCHEMES: Under entitlement schemes, all firms undertaking qualifying expenditure are 'entitled' to benefit. The R&D tax concession is a well known entitlement scheme. Loan entitlements are less common but R&D examples include programs run out of the Office of Chief Scientist in Israel and for education costs, the Australian HECS/HELP scheme. Entitlement grants, such as tax incentives, are generally given *ex post* but others, such as HECS/HELP, are given *ex ante*.

It is common to describe entitlement schemes as being advantaged for being 'market mediated'[4] thereby reducing the risk of government failure. In practice, the Australian R&D tax concession applies neutrally across all technology types and industrial sectors. One implication of this is that it automatically flows toward the research deemed most valuable by the private sector. However, both entitlements and competitive grant programs can be targeted in principle. The most important fundamental difference

[4] See for example Productivity Commission (2007).

between entitlement schemes and competitive grants stem from differences regarding *who* evaluates project merit or eligibility and the commercial confidentially of the R&D.

INDUSTRY R&D BOARDS: R&D boards are co-operative industry-owned groups that fund R&D for the benefit of the members. Industry is free to design the mechanism by which resources are allocated. Source funds typically come from a mix of industry levies, membership fees and government funds.[5] In Australia, R&D corporations exist to collect and allocate R&D resources for most agricultural industries, but there are a few analogous R&D boards operating in the manufacturing and mining sectors.

In R&D boards, strategic research priorities are identified by the industry through a range of consultative activities and the research is targeted at specific industry needs. The approach is typically one of problem solving – identifying key challenges facing the industry, isolating sub components and funding projects which promise to make the biggest impact on the nominated problem.

Industry R&D boards are individually crafted to suit the specific industry structure. Many are composed of small independent operators (such as primary producers), for whom technology is not a usual nexus of competition. However, there are several examples of industry R&D groups comprised of a small numbers of technologically sophisticated manufacturers and miners who are otherwise in direct competition with one another.[6] These tend to only fund R&D that is common to all members, such as basic research or research focused on industry-wide issues (like health and safety). For such organisations to work, members must have similar technological needs and be able to find areas of common technological interest, where the benefits of cooperation outweigh competitive considerations. The most suitable industries are those comprised of many price taking firms; where it is feasible to levy members in a way that is perceived as fair and equitable; and, those where technology is not the primary nexus of competition.

[5] Rural RDCs are funded from industry and government in the ratio 1:1. Other industry groups differ.
[6] Such as Dairy Innovation Australia, the Australian Coal Association Research Program and the Australian Mineral Industries Research Association Limited. These operate in a range of ways but each with the general objective of investing in intangibles, largely technology, for the good of the industry.

4. Primary data collection

To inform our study we undertook eighteen semi-structured interviews with program managers and independent consultants (who advised firms wishing to access public R&D support) across Australia in March and April 2011. Interviewees were chosen if they had had long-term experience with one or more large government programs or R&D boards.

We also undertook a survey of chief technology officers or research managers at 171 large Australian R&D active firms. The sample was drawn from the IBISWorld database for Australia which includes the largest 2000 companies resident in Australia. As shown in table 1, 59 competed the telephone interview, 64 did not want to participate, 9 were not interviewed as their contact details were out-of-date and 39 agreed to be interviewed but were unable to be scheduled into the available time frame.

Table 1: R&D active firm survey responses, 2011

Response	Number	%
Completed survey	59	34.5
Applied for a grant in the past	38	22.2
Only considered applying for a grant	8	4.7
Never considered applying for a grant	13	7.6
Did not want to participate	64	37.4
Dead record / could not be contacted	9	5.3
Contacted but not completed survey due to timetabling problems	39	22.8
TOTAL	171	100.0

Note: Population of firms derived from IBISWorld Business Information

Finally we conducted a survey of 147 past grant recipients and the summary descriptives are presented in Table 2. Interviewees for the Grant recipient survey were the nominated contact person for 147 recipients of closed large government R&D grant programs. 61 completed the telephone interview, 28 did not want to participate and 30 were not interviewed as their contact details were out-of-date.

Table 2: Grant recipient survey responses, 2011

Response	Number	%
Completed survey	61	51.3
Did not want to participate	28	23.5
Dead record	30	25.2
TOTAL	147	100.0

Note: Population of firms derived from AusIndustry web site.

Respondents were asked questions about their experience with government R&D support, their motivations for applying or not applying and what they felt were the strengths and weaknesses of scheme designs. Where possible, survey questions focused on revealed behaviour rather than the opinion of respondents.

5. Design parameters

We identify four fundamental design parameters common to any form of government support for R&D:

Total program funding — Capped or uncapped?

Firm engagement — How does the scheme recruit business interest?

Project selection — What criteria are used and who selects the projects?

Payment structure — How is financial support structured?

Administrative costs — What is the burden?

(a) Total program funding – capped or uncapped?

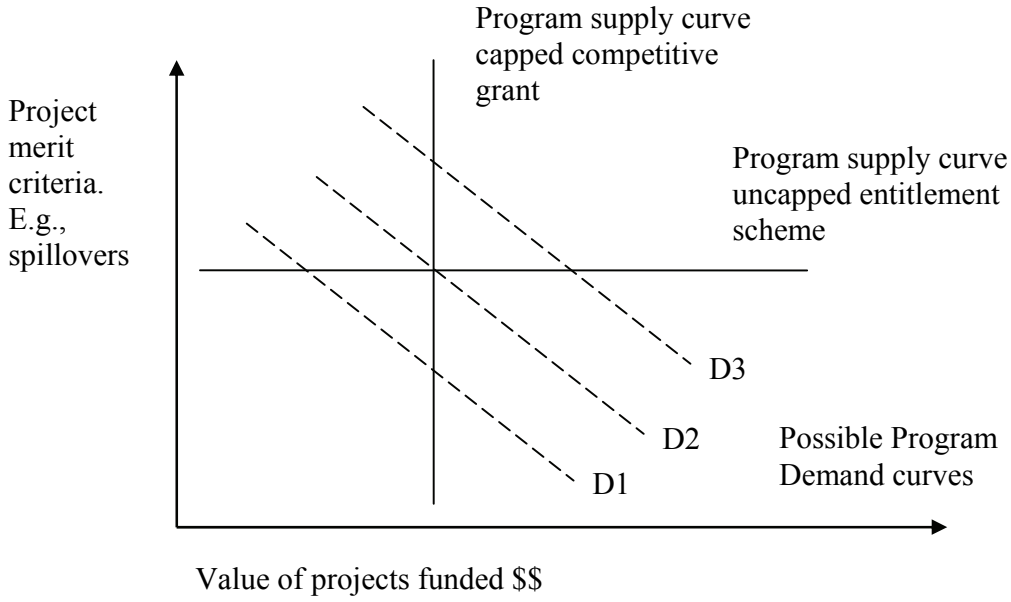
An important theme raised by program administrators is the issue of 'under-subscription' – that is, does the scheme attract a 'sufficient' number of quality applicants. In this section, we propose a simple framework for thinking about program design and the supply of program funding and trace out some implications.

Ex ante the government does not know, with certainty, what the demand for a program will be (or equivalently the quality of the projects that will be put forward). The lower the merit threshold, the more projects will be eligible (greater demand). In principal, with a capped grant scheme, the quantity of expenditure is set and the quality of projects funded is determined by the market. In the case of an uncapped entitlement scheme, the reverse is true, a quality threshold is defined *ex ante*, and all the uncertainty manifests in the rate of uptake (demand for the scheme).

Figure 1 illustrates this trade off. Project merit is the rationing device (what the government seeks to 'buy') and is increasing along the vertical axis.[7] The total dollar value of projects that are funded by a scheme is increasing along the horizontal axis. The diagonal lines indicate possible demand for the scheme (that is the $$ value of applications for the merit level required by the scheme), which is unknown ex ante. Administrators define the program supply curve. For example, the program supply curve from an uncapped entitlement scheme can be represented as a horizontal line. A capped competitive grant scheme exhibits a vertical supply curve.

The intersection between program demand and supply curves defines the equilibrium amount of program funding and the merit criteria of the marginal project funded. This shows that if market demand turns out to be low (as is represented by D1), a capped competitive grant will end up funding a greater total value of projects and will fund projects with a lower level of merit than an uncapped entitlement scheme. Conversely, the demand for a program is revealed to be high (represented by D3) an uncapped entitlement scheme will end up funding more projects of a lower quality. If market demand for the scheme is D2, the thresholds are set such that each scheme design will result in the same volume of expenditure for projects of identical quality.

[7] In practice, projects are evaluated against multiple criteria, but in order to ordinally rank projects these must be reduced to a single index or measure according some weighting scheme.



This framework highlights the different risks affecting governments implementing each type of scheme. For instance, if demand for a program is low, a capped competitive grant scheme will result in either under-subscription (with unspent funds remaining) which might be remedied by lowering of project quality merit criteria to an undesirable level. Alternatively if demand is higher than anticipated, a capped competitive grant scheme will result in 'excess' demand; with many applicants being denied funding. In the case of entitlement schemes on the other hand, risk is manifest as uncapped liabilities which can blow out if demand for the scheme is considerably higher than anticipated. For a range of reasons governments may put more weight on one or the other of these program design risks.

Entitlement schemes are generally self-assessed with compliance monitored via (random) auditing. Merit criteria must be a codified, consistent, and universally understood, threshold of the desired project attribute. Alternatively, in the case of competitive grants, projects are ranked and funds awarded to the best projects such that available funds are used up. The threshold is ultimately determined by the quality and number of program applicants. Grant applicants compete against each other rather than against fixed criteria. From the applicant perspective, this significantly increases the uncertainty regarding whether the firm will receive funding or not.

This framework also highlights the value of estimating program demand at the policy design stage. An accurate estimate of program demand can contribute to managing program design risks and determining how these risks should be managed, inter alia, via using capped or uncapped funding model and whether to open the scheme continuously or in rounds.

(b) Firm engagement

Our interviews and both business surveys revealed that the cost of knowing about industry grant schemes is larger than most people imagine. R&D managers in large firms are often not aware of large R&D grant programs and SMEs are even less informed. The problem appears especially acute for programs that change often. While 6-8 years may represent a long-lived program from governments' perspective, this is not long enough to become well-known and effectively utilized by industry.

Several respondents provided anecdotal evidence that many smaller firms are still not aware of the R&D tax concession even through it has existed for 25 years. According to our interviews, large firms are advised by large accounting firms and have the greatest awareness and engagement in the R&D tax concession scheme. A study of OECD countries by Guellec and van Pottlesburge (2003) concludes that greater the variance in R&D tax incentive policy undermines the observed effectiveness of the policy in inducing additional R&D investment.

Grant program administrators appear aware of this issue, noting that clarifying program requirements is a key request from potential applicants. Similarly there is recognition that it takes time to build interest in a new scheme via educating the population of potential applicants. In sectors with a high degree of foreign ownership, such as automotive manufacturing, any R&D scheme ultimately must influence the behaviour of parent firms whose attention may be harder to get.

One in five large R&D active firms we interviewed had not even considered applying for a grant. Survey respondents who had applied for R&D grants were also given the opportunity to make open ended comments regarding their experience. Collectively, by

far the most common themes reported related to communication and understanding the 'rules of the game'. We spoke to eight firms who had considered applying for a grant, but ultimately did not do so. Several firms nominated commercial sensitivity, that is, not wanting to disclose details of their R&D programs and also not wanting to share IP (especially in the case of collaborative R&D grants). IP issues were the second most commonly raised theme by all firms when asked for open ended comments about how to improve scheme design.

In order to better understand the positive design attributes of schemes, program applicants were asked about their motives for applying. Responses, which are presented in Table 3, indicate that the main reason for applying was because the criteria fit the firm's project and there was a high rate of financial support.

Table 3: Why did you choose to apply for this particular grant scheme? n=61

Stats	mean
Criteria fit my project	83
Easiest application process/lowest cost	3
High rate of financial support	33
Belief that the applications would be evaluated by experts	3
No need to pay it back	6
Requirement for co-funding was not a problem	2
Low IP stipulations.	5
High probability of success	8
Other	11

Source: Grant recipient survey, 2011.

We spoke in more detail to the eight large firms who had considered applying for a grant, but ultimately did not do so. As shown in Table 4, the most common reason for not applying was because the grant value was too small. Other common reasons include commercial sensitivity, not wanting to disclose details of their R&D programs and also not wanting to share IP (especially in the case of R&D linkage grants). This concern was echoed in the open-ended responses. Availability of matched funding was not seen as a barrier to application, in fact, this was the least most common reason nominated.

Table 4: Reasons for not applying for a grant, n=8

Reasons	Importance
Your R&D projects are too small to be eligible	0.429
Not able to get the internal matching funds required	0.143
Project didn't fit the criteria	1.142
Too much paper work involved in application	0.571
Too much paper work involved in progress reports	0.571
Grant too small	1.714
Commercial sensitivity – don't want to disclose R&D information.	1.429
Those administering the scheme don't have the skills to evaluate projects.	0.333
Didn't want to share project IP	1.429

Note: Importance is the mean of responses to the question "Why didn't your company apply?" Responses were weighted "yes" but the answer was unprompted = 3; "major problem" after prompting by the interviewer= 2; "minor problem" after prompting by the interviewer= 1; "no problem" after prompting by the interviewer=0. Population of firms derived from IBISWorld Business Information.
Source: R&D Active survey, 2011

Our surveys of firms also found that stakeholders believe that selection 'rules' change without warning or are opaque. In the words of one respondent:

Changes in the administration and administrators mean a vast amount of money is spent on adapting applications and recalibrating arguments, to fit the changing priorities of funding boards.

Even though State and Commonwealth governments have run R&D grant programs for many decades it is widely accepted by both administrators and participants that new programs still have program specification and administration teething problems. We speculate a number of possible reasons why this might be the case. First, there may be issues to do with the public service retaining corporate memory. Alternatively it may be that each new scheme is 'over-engineered' to meet unreasonable program objectives. Finally, a consistent underestimate of the high costs to industry in understanding the rules of the game for each new iteration of R&D grant schemes might provide some explanation.

While program consistency should be a goal, sometimes change is necessary. When this is the case, is important to clearly communicate these to industry. As part of our business

survey, we asked grant applicants how they heard of the grant programme. Results, which are summarised in Table 5 below, show that, 41 per cent of firms found out about R&D grant programmes through their industry association. Other important sources of information about relevant schemes are government referral services (29 per cent) and consultants (19 per cent).

Table 5: How did you hear about this grant? n=61

Source	Proportion of respondents
Internet search	15
Industry group	41
Print advertising	3
Government referral service	29
Word of mouth	19
Consultant	19
Other – mainly relating to the unrealistic selection criteria and the bureaucratic demands.	2

Note: Mean of responses to the question "How did you hear about this grant?" yes=1, no=0. Population of firms derived from AusIndustry web site, see appendix for details of survey results. Note, that multiple responses were allowed so the total sums to more than 100 percent.
Source: Grant recipient survey, 2011.

The R&D board model is believed to have advantages over standard government administered grants in regards to industry engagement. Since the R&D Board is owned by the industry they have strong incentive to actively engage with their members. The boards and their committees reported having enduring relationship with the relevant research community. However, it they also noted the high cost of identifying and negotiating projects that have shared benefits. In practice, government influence appears to have been important in establishing existing industry groups.[8]

(c) Project Selection

Project section involves two elements: what are the selection criteria? And; who judges projects against these criteria?

[8] Rural RDCs were established by an act of parliament (*Primary Industries and Energy Research and Development Act 19*89). Stakeholders claimed that they believed Government also played an important role in the other industry R&D corporations we identified.

Four selection criteria are commonly used:[9]

1) Technological feasibility and capabilities of the applicant
2) Private benefits i.e. commercial viability
3) External benefits i.e. spillovers to people outside the firm
4) Additionality i.e. will it lead to more R&D?

4a) Risk – while project 'riskiness' is not usually a selection criteria, the standard definition of R&D activity (including for taxation purposes) stipulates that such activity must reflect appreciable risk. To the degree the R&D subsidy lowers the cost of these investments, it implicitly targets additionality.

Good program design should ensure that decision makers have the information as well as the incentives to allocate resources to the best projects according to the desired criteria. In the case of entitlement schemes, it is up to program beneficiaries to self assess. In competitive grant schemes, project assessment (and therefore funding allocation) is undertaken by 'independent' committees.[10] In principal, independent evaluation can improve allocation if the incentives of potential beneficiaries differ from those of the government. However, we argue that it is easy to overstate the advantage.

Co-contribution (i.e., matching funds) is a universal feature of government support for business R&D. Co-contribution aligns the incentives of grant applicants with those of the government when it comes to assessing technological feasibility and private benefits. This means assessment according to these criteria should be undertaken by the group with advantage in information and knowledge. The relative skills and access to information between applicant and government committee is likely to vary. Sophisticated firms are likely to have better information on the technology and market than independent award committees, whereas this may not be the case regarding backyard inventors.

[9] E.g., the Commercial Ready Program criteria are: (1) Management capability of the applicant (2) Commercial potential of the project; (3) Technical strength of the project, and the technical capability and resources available to the applicant (4) Extent to which the project is likely to provide National Benefits (5) Need for funding.

[10] IN the case of R&D boards allocation is by consensus among beneficiaries. It was described by industry participants that committees often take a more active ongoing role in shaping and directing the research to industry needs, so it is not a 'one-hit game'.

Even so, government appointed selection panels are unlikely to possess expertise in *all* the technology, industry and market areas they are required to cover. This problem may be a function of Australia's small size and thus we should be cautious about copying schemes from US or Europe without accounting for this handicap.[11] Lack of selection committee expertise was cited by survey respondents as the main reason why people though their application had been unsuccessful. In fact, it will be difficult to for bureaucratic or multi-disciplinary based scientific committees to determine when they have information advantage. We suggest that since there is no justification for selection committees to assess either technological feasibility or commercial viability, these should not be part of the selection criteria. Any perceived lack of sophistication of small innovators is better dealt with via the provision of information and referral services.

However, funding recipients do not have an incentive to accurately assess expected project spillovers or additionality. But can government oversight accurately measure these project attributes?

In the case of competitive grants, applicants are asked to show evidence that they were unable to acquire funding from other sources. Using selection criteria to target marginal projects are unlikely to be successful, and will introduce considerable inefficiencies. As one respondent stated:

The assessment of the scheme can be contradictory, on one hand you must prove that the project is very risky, while at the same time that it is immediately commercial.

These results are supported by a growing body of empirical evidence. Fellner (1992) found that most program administrators have difficulty predicting additionality in proposals (see also Lach 2002). In our survey about half of unsuccessful grant applicants reported that their project did eventually go ahead, albeit in reduced form. However, it is critical to note that project level additionality is not a requisite for R&D additionality at the firm level. This is because, if a firm's best project is awarded a grant, this frees up

[11] Large and well-known US examples of targeted grant based programs include Defense Advanced Research Projects Agency (DARPA); ARPA-E (Advanced Research Projects Agency-Energy); the Advanced Technology Program and SEMATECH.

resources to fund other more marginal projects (i.e., lowers the average cost of capital). There has been a lot of academic and government research, especially overseas, measuring additionality at the firm and industry level and the specific estimates vary considerably. [12] On average, European studies are more likely to find additionality and US studies are more likely to find that R&D support lowers the firm's own R&D spending. These differences could be due to the program mix or the prejudices of the researcher. There is no evidence that schemes designed to induce additionality increased R&D activity by more than schemes not designed in this way.

Tax-based entitlement schemes often attempt to target marginal expenditure by paying out on company expenditure that is over and above some pre-defined base is eligible. For example, a bonus rate on incremental expenditure has been a feature of the Australian scheme since 2001. Despite being common internationally, there is no evidence on the effectiveness of such targeting and indeed the theoretical prediction is that such targeting will encourage industry to inefficiently oscillate their R&D programs (see Richardson and Wilkie 1995). The net predicted effect is no long term additionality.

Selecting R&D projects based on industry consensus, as is the case in of R&D boards, provides a unique solution to the additionality issue. Members will resist funding research projects they are performing anyway and should focus on projects with maximum intra-industry spillovers. However, industry groups do not have an incentive to fund research that has significant extra-industry knowledge spillovers. Superficially, it might be considered straightforward to motivate industry groups to undertake extra-industry spillover research. However some stakeholders we spoke to advocated that independence and operating strictly in the industries interest represent key advantages of industry R&D boards. Identifying common ground between participants is complex enough without also trying to meet government funding criteria.

In summary, we find that benefits of third-party project assessment by selection committees are unlikely to outweigh the costs in many instances. Of the four standard

[12] Hall and Van Reenan (2000); Wallensten (2000); Klette and Moen (2010); Lach (2002); Conzalez, Jaumandreu and Pazo (2005); Almus and Czarnitzki (2003); Blanes & Busom (2004); Aerts and Schmidt (2008); Clausen (2009); Ebersberger (2005); Bayona-Saez and Garcia-Marco (2010); David, Hall and Toole (2000); Lindstrom and Heshmati (2005).

grant criteria, co-contributions make two of these (technical feasibility and commercial viability) redundant. Further there is no evidence that targeting additionality is effective. However, there may be some case for grant assessment of externalities. In contrast, entitlement programs, are self administered, and as such avoid the use of selection committees. The implications are that the administration cost is lower and uncertainty (for the firm) is reduced. However, it would be difficult, but not impossible, to use an entitlement scheme to target projects with spillovers above a certain threshold.

(d) Payment structure

Program design attributes include determining the minimum and maximum amounts offered; whether payments are made as a grant, a loan or equity; and whether the firms' own matching funds are required. As noted previously, co-contribution is an important mechanism for aligning the commercial incentives of grant applicants and the granting body. Matching formulas ensure that the firm has 'skin in the game'; minimises rent seeking; and improves the quality of proposals. The higher the (firms) co-contribution requirement, the more closely funded projects are to market-driven projects, which probably implies that the higher the co-contribution, the less risky and less novel the investment..

Most stakeholders we interviewed considered that the size of the grant determined how much behavioural change the grant program can be expected to 'buy'. The 61 grant recipients surveyed for this study, nominated the rate of financial support as the second most important factor in deciding to apply (after project fitting the program criteria). Similarly, for those firms interviewed who thought about applying for a grant, but did not, the biggest reason was the grant was too small.

However, matching fund programs are not suitable for firms which are unable to access capital markets, obtain other forms of credit (e.g., trade credit) and have limited retained earnings. The international literature provides some support for the hypothesis that firms can be liquidity constrained in their R&D investments (see Hall 2005). Generally, smaller firms, firms with less cash flow and firms investing in upstream technologies, are more likely to be capital constrained. By contrast, large firms are less limited and Thomson

(2010) finds no evidence that large Australian firms are generally liquidity constrained in their R&D investments.

As part of our survey, we asked grant recipients for their opinion about different forms of support with specific reference to: guaranteed loans, government-sponsored venture capital and repayable grants. Responses from firms, which are summarised in Table 5 below, suggest that the respondents are, on balance, positive about these other modes of support. However, administrators interviewed identified the obvious problems with recouping monies from firms who had failed, or firms which had not completed their R&D project.

Table 6: Perceptions of grant recipients of different types of government support, n=61

Support type	View Positively	View negatively	Unsure
Government guaranteed loans	17	8	5
Government sponsored venture capital	17	11	7
Repayable grants	16	10	7

Source: Grant recipient survey, 2011.

Tax-based entitlement schemes typically give lower rates of per project subsidy than grants. Historically in Australia the R&D tax concession has provided a subsidy in the order of 10 cents per dollar of R&D expenditure, compared to the standard 50:50 funding rules for grants. In the case of industry R&D boards project proposals generally include some contribution from the researcher (applicant), be it in-kind or cash..

(e) Administrative costs

Entitlement schemes and competitive grants also have obvious differences in regards to administrative costs, both to government and to applicants. In 1998-99 the ratio of administration costs to program expenditure was three times higher for R&D Start (6%) than for the R&D tax concession (2%).[13] Our 'Grant Recipient Survey' found that firms typically devote 2-3 weeks of staff time, with about 20-30 percent of firms engaging an external consultant.

[13] Evaluation of the R&D Start Program, the Allens Consulting Group.

However, we show in Table 7 that successful applicants were not deterred by excessive 'paperwork' associated with applying for grants but they did see reporting requirements as a burden. By contrast, the more general population of R&D active firms, shown in Table 8, had a negative view of both the demands of the application and reporting process.

Table 7: Element of grant scheme that could be improved.

Decrease paper work involved in application	0.541
Decrease paper work involved in reporting to the government, progress reports etc.	0.746
Increase grants size	0.540
Increased success rate	0.254
Commercial sensitivity	0.254
Ownership of IP	0.338
Other (specify)	0.460

Note: Importance is the mean of responses to the question "Are there any elements of the grant scheme or administration could be improved?" Responses were weighted: "yes" but the answer was unprompted = 3; "major problem" after prompting by the interviewer= 2; "minor problem" after prompting by the interviewer= 1; "no problem" after prompting by the interviewer=0. Population of firms derived from AusIndustry web site.
Source: Grant Recipient survey, 2011

Table 8: Element of grant scheme that could be improved

Commercial sensitivity	0.861
Paperwork- application	0.722
Paperwork – reporting	0.600
Grants too small	0.639

Note: Importance is the mean of responses to the question "Are there any elements of the grant scheme or administration could be improved?" Responses were weighted: "yes" but the answer was unprompted = 3; "major problem" after prompting by the interviewer= 2; "minor problem" after prompting by the interviewer= 1; "no problem" after prompting by the interviewer=0. Population of firms derived from IBISWorld Business Information.
Source: R&D Active survey, 2011

Another reoccurring theme in our consultations was that requirements for the application do not reflect the magnitude of the grant. Many applicants were bothered by the fact that small grants required the same amount of paper work as large grants. Administrators we spoke to were aware of this potential problem. Best practice policy should would equate the marginal cost of administration, with the marginal benefit in terms of quality of grant or merit criteria achieved. This ideal is probably not achievable in practice and grant programs should aim to ensure the evidentiary requirements are equal per government

dollar spent. That is, lower requirements for small amounts of money and higher requirements as the magnitude of the grant increases.

We have no comparative evidence on the cost of running R&D boards. The decision regarding the optimal ratio of administrative to administered funds is left to industry members to determine on a case by case basis.

6. Conclusion

A priori we argue that the best R&D scheme should engender lasting innovation capabilities in the economy and embody enough flexibility so that support can re-orientate itself towards changing opportunities and needs. A desirable scheme should:

Be enduring enough to form a stable and predictable source of funding for industry;

Embody clear and unambiguous rules that are easy for industry to discover and interpret;

Allow little or no scope for bureaucratic discretion and political interference in the selection process;

Avoid over-engineered selection criteria. Schemes should not have a requirement of additionality, with unachievable or unmeasurable goals

This paper represents a small step towards a more systematic understanding of the strengths and weaknesses of different forms of public R&D support. The main strengths of entitlement schemes are the strong firm engagement and low administrative costs. However, they are blunt instruments for targeting inter-industry spillovers and usually deliver modest benefits to each R&D project. Competitive schemes can, on the other hand, be used to target inter-industry spillovers and can be designed to be generous to the selected projects. However, it is difficult to engage the industry in the program, especially due to high transaction costs (from both sides) and the need by firms to keep their R&D confidential. R&D Boards on the other hand will not exist without significant industry engagement and are arguably the best program for building long-term R&D capability however industry has to agree to establish them and pay regular levies. We summarise our main points in Table 9.

Table 9: Summary of schemes against design parameters

Design parameters	Entitlement schemes	Competitive schemes	R&D boards
Total funding	Uncapped	Capped	Capped
Firm engagement	Reasonably well-known except for some SMEs; inflexible with respect to industry and technology.	Costly to engage firms; hard for firms to discover; commercial sensitivity problems; can be flexible with respect to industry.	Not sustainable without strong engagement. Excludes firms outside target industry
Project selection	Eligibility rules determined by bureaucratic units such as ATO. Firms self evaluate. Limited scope to target spillovers.	Often use government appointed selection committees. Selection is subjective and potentially discretionary. Often target spillovers, but little evidence this is successful.	Selection by industry members (ballot or member committee). Targets intra-industry spillovers but not society-wide spillovers.
Payment structure	Always matching money but least generous.	Often matching money	Varies – can be in-kind matching resources.
Administrative costs	Low. No reporting, only random audits.	Expensive, 2-3 weeks spent by firms in application.	Costs borne by industry

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