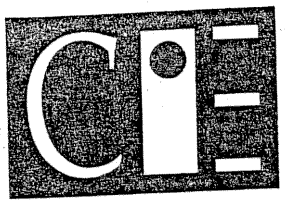

CENTRE FOR
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Review of the R&D Start Program

Prepared for

Department of Industry, Tourism and Resources

Centre for International Economics
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Summary

Under the Government's R&D Start Program, over $700 million in grants and $70 million in loans have been issued since 1996. Ensuring these resources are invested where they provide significant national economic benefits is a major policy issue.

A quantitative review to determine national benefits

The purpose of this review is to evaluate the program's performance. The objectives of the review are:

- to quantitatively assess the national economic impacts (benefits and costs) of the Start program — this has involved:
  - collecting quantitative information on the outcomes of R&D Start funded projects,
  - incorporating this information into an economic model to determine market and non-market impacts, and
  - assessing the private and public benefits and costs in a financial model to determine the net impact;
- to assess the relative effectiveness of various parts of the program (although data on Start Plus and Start Premium proved to be insufficient for assessment purposes); and
- to make recommendations about the design of the program to improve its efficiency.

The (then) Industry Commission has noted that:

> ...a social benefit–cost framework is fraught with difficulty. Of the elements involved, the one which is both critical to the outcome and involves great uncertainty is the spillover return to the additional R&D induced. (Industry Commission 1995, p. E.20)

Rationale for government funding to support private R&D

Special economic features of R&D mean that it can deliver benefits that are not easily transacted in the market place. All economic activity creates flow-on benefits to business customers, competitors, consumers and the community more generally. However, R&D is a special case in that it also creates spillover benefits for the community.

The most common spillover benefit associated with R&D is expanded knowledge. This can produce far-reaching benefits that diffuse through the economy. As knowledge is easy to imitate, the benefit from new knowledge is spread widely throughout the community. As this benefit — known as a knowledge spillover — does not go to the researcher, there can be an under-investment in R&D.

Patents and other forms of intellectual property protection are designed to help producers of R&D gain the benefits from their innovations. This is designed to increase the incentive to invest in R&D. However, it is not always possible to adequately protect intellectual property and various forms of protection do not internalise all spillover benefits, so under-investment in R&D may occur. In other words, the return to the wider community of R&D can be greater than the return to the private firms who might conduct it.

Primarily, the rationale and economic justification for offering Start subsidies for R&D is to fill the gap between private and community returns that might arise due to knowledge spillovers and provide extra incentives for private companies to conduct higher levels of R&D.

A secondary rationale may be to overcome perceived problems relating to the availability of funds for risky R&D. The presumption is that, for reasons of risk, moral hazard or bad communications, the capital market cannot be convinced to fund some forms of R&D.

The government subsidises otherwise rejected R&D, encouraging it to occur on the premise that the extra benefit to the nation will exceed the extra cost of conducting it.

Our approach

In this study we survey Start grant recipients to assess the difference that the provision of Start funds has made. We assess how much extra R&D was induced by the R&D grant and what additional national economic benefit may have followed from the extra investment.

Key findings: high R&D returns

Responses from grant recipients indicate:

- high expected private returns from their R&D;
- the main economic impacts of the R&D to be:
  - the development of a new or better product, service or process (50 per cent),
  - the development of technology to reduce respondent's costs (8 per cent),
  - increased intellectual property (22 per cent), and
  - increased opportunity to engage in new ventures for collaboration (20 per cent);
- high levels of protection of the intellectual property associated with the R&D;
- high expectations that they will be able to retain the competitive edge the R&D will confer, provided they maintain ongoing R&D;
- that two-thirds expect that further government assistance would be required to allow them to maintain their competitive edge; and
- that over half who responded expect an increase in skills of their employees and the development of a platform technology as a significant benefit to their firm.

However, although private returns and total returns are high, the value of the Start program is dependent on the degree of additionality — the extra national benefit. Interpreting the data from grant recipients, there are high additional national benefits — 33 per cent of the total benefits is attributed to the Start funding, resulting in:

- present value benefits $1.0 billion : present value cost $0.22 billion = B:C 4.5:1 for Start funds — that is, for every dollar invested in Start, the community in total receives $4.50 in return; and
- a high rate of return for Start funds — if the same funds were invested in an alternative program, they would need to receive an 11 per cent compounding rate of return (above the discount rate) to achieve 4.5:1.

Recipients' responses suggest that there is a significant private and national benefit from the Start funds. However, it is the split between private returns and spillover returns that will determine which of the two economic rationales for a subsidy is strongest.

High private returns, but spillovers are more difficult to assess

Indicators of spillovers suggest the following.

- About 85 per cent of projects were successfully completed, suggesting that a range of new products and processes were generated and, in the normal process of diffusion, demonstration and commercialisation itself, it should be expected that this will spur on spillovers in the economy.
- Over half (57 per cent) of respondents indicate strongly protecting their R&D, suggesting that they are likely to appropriate many of the gains from their R&D, thus reducing spillovers, but raising the private returns from R&D.
- Between 10 to 20 per cent indicate novel or platform technologies that might be of benefit to firms other than their own:
  - high spillovers are expected to be associated with basic R&D or R&D focused on developing processes or platform technologies; and
  - possibly lower spillovers are expected to be associated with the applied or product oriented R&D mostly conducted through the Start program.
- Around 90 per cent of respondents do not expect to quickly lose their competitive edge to rivals (in under five years) and about 75 per cent of increased sales resulting from the R&D are expected to be exports.
- Twenty-four per cent of recipients involved collaborators in their R&D.
- Twenty per cent of firms indicate that increased skills of their workers may provide spillover benefits (in the form of technical and commercial know-how) to other firms in their industry and 10 per cent of firms indicated the potential of benefits to spill over to firms outside their industry.

Spillover estimates

Although estimates of the present value knowledge spillovers are wide ranging:

- most Australian reviews of R&D subsidy programs have placed them between $0.25 and $0.90 for each dollar of R&D, however it is possible to derive estimates as high as $5.52 (table 1);
- it is difficult to interpret most foreign studies on the question of spillovers – however, the differences between total returns and private

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

	Study location	Spillover only	Total return from R&D — private plus spillover
		%	%
Productivity Commission 2003 (clinical R&D)	Australia	25	
Productivity Commission 2003 (pre-clinical R&D)	Australia	58	
Lattimore 1997	Australia	70	
BIE (1993)	Australia	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	Australia	122	
Griliches and Lichenberg 1984 (product R&D)	Foreign		235
Griliches and Mairese 1990 (USA)	Foreign		100–130
Griliches and Lichenberg 1984 (process R&D)	Foreign		136
Many studies, Industry Commission 1995, table QA3 (all R&D)	Foreign		246–300
Derived from Industry Commission 1995	Australia	382	361
Mansfield various (basic R&D)	Foreign		468
Derived from Industry Commission	Australia	552	

returns (one indicator of this) could be as high as \$1.06 and a similar derivation for Australia is as high as \$1.22 (table 1); and

- most studies do not indicate how levels of spillovers vary by indicators of knowledge spillovers — however, 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 (table 1).

Inducement estimates

Estimates of the percentage of each dollar of R&D subsidy that ends up inducing more R&D also vary widely. Of each dollar of R&D subsidy, some may crowd out funding that would have occurred anyway. Further, because of diminishing returns to each additional dollar of R&D invested in a project, it is unlikely that in a matching dollar grant scheme, all of each extra dollar will be spent on extra R&D.

- A third of recipients indicated that they would probably have proceeded with their R&D projects anyway using alternative funding. About 50 per cent implied they would probably not have proceeded and about 15 per cent did not answer.
- On average, recipients suggested that the scope of their projects would have declined by about a third due to a lowering of the probability of success and delays to time of completion, had they not received Start funds.

- Ninety percent of recipients expected that the project cost to them would have increased by about 70 per cent had they not received Start funding.
- On average, recipients indicated very high private rates of return — around 4.5:1 present value benefits to costs — and therefore large incentives to undertake the projects.
- Given high rates of private returns and assuming there is no capital market failure, reasonable analytical interpretations of the recipients' responses suggest inducement rates could be anywhere between about 20 and 80 per cent.

Implications for Start benefit to cost ratios

The implications of the varying spillover and inducement rates are set out in table 2. With an assumed inducement rate of around 50 per cent, present value spillover returns need to be in excess of $0.66 to breakeven.

The uncertainty surrounding estimates of the economic payoffs from spillovers leaves some doubt about the economic payoff from Start. The economic payoff may be higher than breakeven, especially if the higher estimates of most Australian studies are applicable to Start induced R&D.

2 Benefit to cost ratios by spillover and inducement rates

Inducement rates \ Spillover rates: Present value $ benefits per $ of R&D	0.25	0.28	0.34	0.41	0.51	0.66	0.87	1.23	1.75	1.94	4.09	5.53
	← Most previous Australian reviews →											
0.10	0.73	0.73	0.74	0.74	0.75	0.76	0.78	0.80	0.84	0.85	1.00	1.10
0.20	0.76	0.77	0.78	0.79	0.80	0.82	0.85	0.90	0.97	1.00	1.30	1.50
0.22	0.77	0.77	0.78	0.79	0.81	0.83	0.86	0.92	1.00	1.03	1.36	1.58
0.30	0.79	0.80	0.81	0.83	0.85	0.88	0.93	1.00	1.11	1.15	1.60	1.90
0.40	0.83	0.83	0.85	0.87	0.90	0.94	1.00	1.10	1.25	1.30	1.90	2.30
0.50	0.86	0.87	0.89	0.91	0.95	1.00	1.08	1.20	1.38	1.45	2.20	2.70
0.60	0.89	0.90	0.93	0.96	1.00	1.06	1.15	1.30	1.52	1.60	2.50	3.10
0.70	0.92	0.93	0.96	1.00	1.05	1.12	1.23	1.40	1.66	1.75	2.80	3.51
0.80	0.95	0.97	1.00	1.04	1.10	1.18	1.30	1.50	1.79	1.90	3.10	3.91
0.90	0.98	1.00	1.04	1.09	1.15	1.24	1.38	1.60	1.93	2.05	3.40	4.31
0.95	1.00	1.02	1.06	1.11	1.18	1.27	1.41	1.65	2.00	2.13	3.56	4.52

However, the applied and product focus of the R&D and the strong focus on exports may mitigate against this.

A benefit–cost ratio above 1:1 suggests that, given the discount rate of 10 per cent used here, it has paid the community to undertake the program because it has covered its costs, including the opportunity cost of funds (the discount rate).

Evidence of spillovers and capital market failures

High expected private and market-mediated returns and uncertain knowledge spillovers for recipients weakens the main rationale for subsidies. Nonetheless:

- recipients have argued strongly that their R&D and its benefits would have been considerably reduced without Start funds — their written responses also emphasise this point; and
- the possibility remains that capital markets may be reluctant to back them, supporting the possibility that the 4.5:1 benefit to cost ratio indicated by their responses may hold some validity — that is, there is a severe capital market failure of some sort.

Implications

Assessed against the objectives, rationale and selection criteria for the program, several implications emerge.

Objectives

Increased number of projects with high commercial potential, fostering greater commercialisation

If there is a strong capital market failure affecting Start recipients, the number of R&D projects with high commercial potential have been increased.

Increased collaboration

About 25 per cent of recipients were involved with collaboration.

Additional national benefits

To make a case for a Start benefit to cost ratio greater than 1:1 based on spillover benefits, it is necessary to demonstrate that spillover benefits are at least equal to or larger than 0.66, with an inducement rate of 0.5 in table 2. That is, they must be at least at the upper end of estimates for spillovers assumed in most previous reviews of this type of program.

On capital market grounds, a stronger case may be made for national benefits than is the case with spillovers, provided that the source of the capital market failure can be identified.

The five selection criteria

Without being sure how firms without Start funds would have performed, it is difficult to assess the efficiency of the selection criteria: management capability; commercial potential of the projects; technical strengths of the projects; 'need for funding'; and national benefits.

The rationale

The primary rationale and economic justification for Start is based on knowledge spillovers. The secondary rationale may be to overcome capital market or information problems in the market place.

Spillovers

For any given estimate of spillover benefit, a constraint faced by Start seems to be the ratio of the spillover benefit to the estimated deadweight costs associated with raising taxes to fund R&D subsidies (which are commonly estimated to be $0.30 for every $1 raised).

- Because of diminishing returns to any project, only a proportion, perhaps 50 per cent, will be spent on additional R&D.
- For example, if the spillover rate is $1 for every dollar of induced R&D, and if the inducement rate is 50 per cent, then the benefit to cost ratio will be 1.2:1 — that is, 1+((1*0.5)-0.3=0.2):1. The higher the spillover rate, the more it is able to cover the deadweight cost.
- Further serious investigation into the robustness of macroeconomic estimates of spillover benefits and the link between microeconomic causes of the macroeconomic estimates is warranted.

Capital market irregularities

If the Start program does truly help solve a capital market deficiency, continuity of Start in some form is desirable. However, given the high expected private returns to the funded R&D, scope may exist to design a more efficient support mechanism. One possibility is a HECS-type concessional loan. The potential recipients should be largely indifferent between receiving the funds in the form of a grant or being given a conditional loan, repayable only upon successful commercialisation and market development. The advantages would be that:

- the net cost in terms of public funds would be reduced;
- all allocated funds are likely to induce R&D and transfers are likely to be minimised;
- more, but smaller, allocations of funds are likely to be made and to be more effective;
- given high expected returns, and no downside risk to applicants, they should be willing to participate; and
- an automatic monitoring of the success of the program would be built in:
  - if rates of return truly are as high as anticipated, repayment of loans with interest would occur and, through time, the scheme could be expanded as required, or alternatively
  - if rates of return fall short of anticipated, failure of the scheme would eventually become apparent and it could be scaled back or eliminated.

Conclusions

Based on the survey data collected and analysed for this review, and in view of the sensitivity tests conducted, there appear to be two possible conclusions about the benefits and costs of the program.

- Assessed against the main rationale for R&D subsidies — knowledge spillovers — the net national benefits of the program are uncertain because of the wide range of estimates of spillovers and the inherent uncertainty of estimating spillovers.
- Assessed against the secondary rationale — capital market irregularities — the possibility exists that the net national benefits are very large, making the program potentially a very good investment for government.

However, direct R&D Start subsidies are a very blunt instrument for dealing with capital market irregularities if they exist.

Two main implications emerge:

- more evidence is required on whether capital market constraints are preventing profitable R&D from going ahead; and
- if they are, then the nature of the constraints needs to be closely identified and an efficient, well targeted policy instrument (probably not a direct subsidy) needs to be devised to deal with it, preferably one that is easy to monitor.

A further implication is that, given the uncertainty surrounding estimates of knowledge spillovers in the Australian economy, serious investigation into the robustness of such estimates is warranted.

1 Introduction

The Commonwealth Government has established a number of R&D funding programs aimed at increasing the level of R&D in Australia. Under the Government's R&D Start Program, around 900 R&D grants have been issued to participants. With up to $200 million a year being spent on the program, over $700 million in grants and $70 million in loans have been provided since 1996. Ensuring these resources are invested where they provide significant national economic benefits is a major policy issue.

Outline of the R&D Start program

The R&D Start program is the main source of Commonwealth direct funding for research and development in the business sector. It aims to give a long term boost to the development of Australia's economy by encouraging innovation and research that leads to new technologies. By encouraging R&D into new technology, particularly R&D with commercial potential, the Government hopes that Australia will develop new products for export and import replacement and a solid knowledge base. Box 1.1 sets out the objectives of the program.

Previous review of the Start program

The Allen Consulting Group conducted a qualitative review in 2000, which reported on the efficiency and effectiveness of the program in meeting its objectives. That review looked at projects that received funds from the commencement of the program in 1996 to June 2000. Two hundred and sixteen questionnaires were sent to Start participants, of whom 128 responded (a 59 per cent response rate).

Allen Consulting reported that 64 per cent of firms achieved additional sales and two thirds were able to employ additional staff as a direct or indirect result of being involved in the Start program. Sixty-two per cent of respondents said that involvement in Start increased their expenditure on R&D.

1.1 The objectives of the R&D Start program

The R&D Start Program, available to non-tax exempt Australian companies, is a merit based program designed to assist Australian industry to undertake research and development (R&D) and its commercialisation through a range of grants and loans.

The objectives of R&D Start are to:

- increase the number of R&D projects with high commercial potential that are undertaken by companies;
- foster greater commercialisation of the outcomes from R&D projects;
- foster collaborative R&D and related activities through companies working together, or working with research institutions; and
- increase the level of R&D and its commercialisation that provides benefit to Australia.

The types of funding assistance available under the Start program include the following.

- **Core Start** offers grants of up to 50 per cent of eligible project costs to Australian companies with an annual turnover of less than $50 million.
- **Start Plus** offers grants of up to 20 per cent of eligible project costs to larger Australian companies with group turnover of $50 million or more. Grants up to $15 million are available, though typically range between $50 000 and $5 million.
- **Start Premium** offers high quality projects the opportunity to obtain further assistance. Start Premium offers companies an additional repayable amount which 'tops up' either Core Start or Start Plus assistance to a maximum of 56.25 per cent of project costs. For larger companies, which receive a grant of 20 per cent of project costs, Start Premium can provide an additional 36.25 per cent of repayable financial assistance. Applicants are required to provide a repayment plan as part of their application.
- **Start Graduate** provides grants to companies with a turnover of less than $50 million to engage a graduate on a specific R&D related project that is undertaken in collaboration with a research institution. Projects can be up to two years in duration. The maximum grant is $100,000 (50 per cent of eligible project costs).
- **Concessional loans** to companies/groups which employ fewer than 100 persons, and which are involved in the early commercialisation of technological innovations. Projects must be completed within three years and the loan repaid in the following three years. Loans are for 50 per cent of eligible project costs.

Applicants need to be able to demonstrate that they can meet their share of project costs and that they have been unable to obtain sufficient funding for the project from financial institutions.

Start grant applicants are assessed according to five merit criteria.

- Management capability.
- Commercial potential of the project.
- Technical strength of the project.
- National benefits likely to flow from a successful outcome.
- The applicant's need for R&D Start funding to complete the project successfully and punctually.

Source: R&D Start website: http://www.ausindustry.gov.au.

The Allen Consulting Group report gave a qualitative assessment of the R&D Start Program. However, it did not attempt to measure the net national benefits of the R&D Start program to Australia, or quantify what would have happened without Start R&D assistance.

The scope of this report

The Centre for International Economics (CIE) has been engaged by the Commonwealth Government, acting through the Department of Industry Tourism and Resources (DITR), to conduct an evaluation of the program's performance. The objectives of the review are:

- to quantitatively assess the national economic impacts (benefits and costs) of the Start program – this has involved:
  - collecting quantitative information on the outcomes of R&D projects funded and alternative projects, and
  - incorporating this information into an economic model to determine market and non-market impacts;
- to assess the relative effectiveness of various parts of the program; and
- to make recommendations about the design of the program to improve its efficiency.

This evaluation differs from the Allen review in that its primary aim is to quantify the outcomes and benefits of the Start program using survey data and economic modelling. The quantitative results provide a basis for measuring the overall efficiency of the program as well as providing insights about how it might be changed to improve its efficiency.

2 The rationale for government funding to support private R&D

The stated objectives of the R&D Start program are set out in box 1.1 and relate to increasing the level and commercialisation of R&D. The broader objective is to stimulate R&D that delivers net national economic benefits to the Australian community. The main argument for government to stimulate R&D by subsidising it, is that:

- firms tend to under-invest in R&D because it is difficult for them to capture a sufficient share of the national benefits from it — this reduces their incentive to invest;
- because the social returns from R&D are considered to exceed the private returns to the firms, subsidies are necessary to fill the gap and provide the extra incentive — private and national rates of return from R&D diverge due to distorted incentives; and
- the social benefit from increased (subsidised) R&D (the private benefit plus the benefit that cannot be captured privately) will be higher than the social costs of funding the subsidy — the net national economic benefit of diverting resources from one area of the economy to R&D will be positive and significant.

Why private and national benefits of R&D might diverge

The rationale as to why private and national benefits from R&D diverge is that:

- R&D provides spillover benefits to some who do not have to pay for them:
  - these benefits spillover because they are difficult for the firm doing the R&D to appropriate through any market mechanism — patents are one mechanism used to overcome such problems, but patents are not easily applied to all outcomes of R&D,

- some R&D outcomes 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 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; and

- because private investors cannot appropriate the spillover benefits, they will tend to under-invest in this activity.

Flow-ons and spillovers

Potentially any investment can provide benefits to firms who did not invest in the R&D. These benefits come in the form 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-ons are a part of the change in economic incentives that help make investment in R&D attractive to firms. Without such flow-on benefits to consumers, for instance, there would be no incentive for them to buy a new product emerging from an R&D project.

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, skills transfer 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;

- 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.

Flow-ons are a wider form of private benefit

In principle, flow-on effects are quite distinct from spillovers. Flow-on effects that are mediated through markets are in fact a wider form of private benefit. The investing firm knows that it can appropriate some of these benefits, and it also knows that, in order to do this, it must offer some benefit to its customers. It also knows that it must try and prevent its competitors from copying its exact innovation and so may use patents, trade secrets, licence fees or market segmentation strategies to capture a sufficient share of flow-on.

Flow-ons are accounted for in the decisions of investing firms and are necessary to allow the market to work and are vital to all investments

Thus, flow-ons are mostly accounted for in the decisions of the firm making the investment. Flow-ons, of course, may turn out to be more extensive than the investing firm anticipated, but the key point is that these flow-on benefits are distributed by market mechanisms.

Picking winners on the basis of flow-ons is inappropriate

Moreover, all forms of investment and economic activity generate flow-ons. Shifting resources 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 many economies that have tried (King 1999).

Spillovers are benefits that are not part of market transactions

Spillovers are benefits that are not accounted for in the decisions of the investors, but nevertheless generate a positive outcome for the economy as a whole.

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

In practice, flow-on and spillover effects may be difficult to distinguish, and the distinction may in part depend on a range of factors including market structures in both output and input markets. This may increase the risk of investing, and if capital markets are unable to assess this risk or efficiently spread it across many similarly risky projects, there could be an under-investment in flow-ons.

Similarly, lack of information or inadequate communication by a start-up firm of its potential market-mediated benefits could limit its access to funds and will result in under-investment in R&D that produces flow-ons. Strictly speaking, although it is the spillovers that are relevant to government R&D policy, there may be some circumstances relating to capital market failures or communication failures when flow-ons could also become relevant.

Spillovers cause market-mediated and social returns to diverge

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. In comparison, returns to capital investment are around 10 to 15 per cent, suggesting possible under-investment in R&D. However, the lower return to capital is likely to be due to the high level of risk associated with R&D compared to the relatively more stable capital investment. Moreover, Dowrick does not split up the difference between private and social return into flow-ons and spillovers. Flow-ons, which are necessary to induce private investment in R&D, may be high and spillovers low. However, if spillovers are high, without government support the level of investment in R&D could be sub-optimal from a whole of society (or national) viewpoint.

An example

How spillover benefits may distort R&D investment decisions for a particular project is set out in chart 2.1. The chart shows an example of the relationship between the level of investment in R&D and the value of private, flow-on and spillover benefits received.

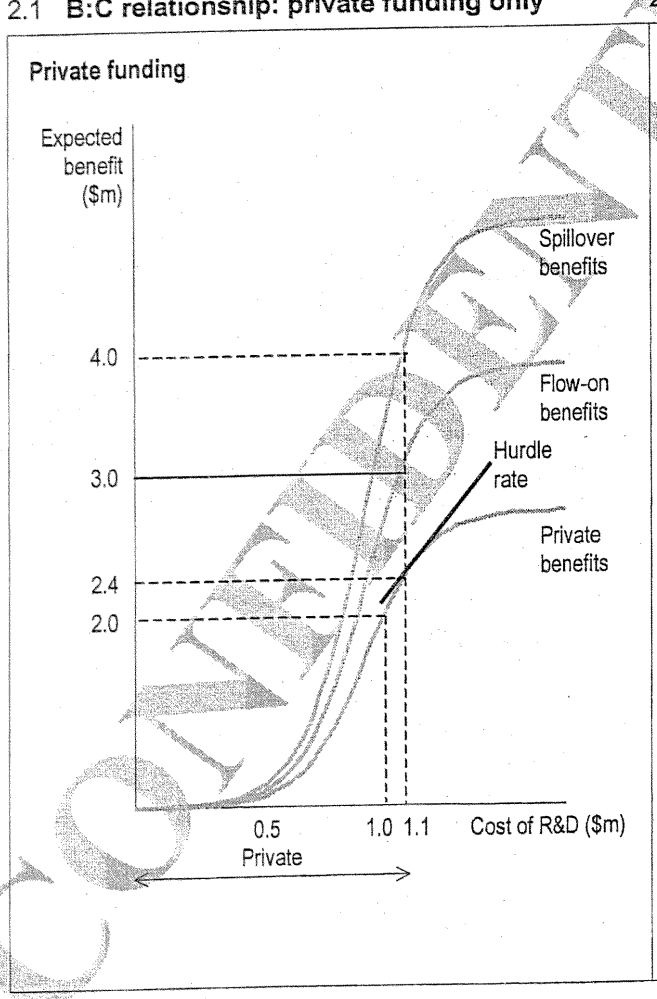
- At low levels of R&D investment ($0.5 million in chart 2.1) little or no benefit is gained — there is a certain minimum investment required to achieve the critical mass necessary to get any benefits from R&D.

- Once the point of critical mass is reached ($0.5 million in chart 2.1), additional R&D spending (an additional $0.5 million) produces increasing marginal benefits.
- For additional R&D spending on the project (in excess of $1 million in chart 2.1), the firm receives diminishing marginal returns to R&D.
- Eventually, additional funding to the project (in excess of say $1.75 million in chart 2.1) will provide no additional private benefits, although it may provide small additional flow-on or spillover benefits.

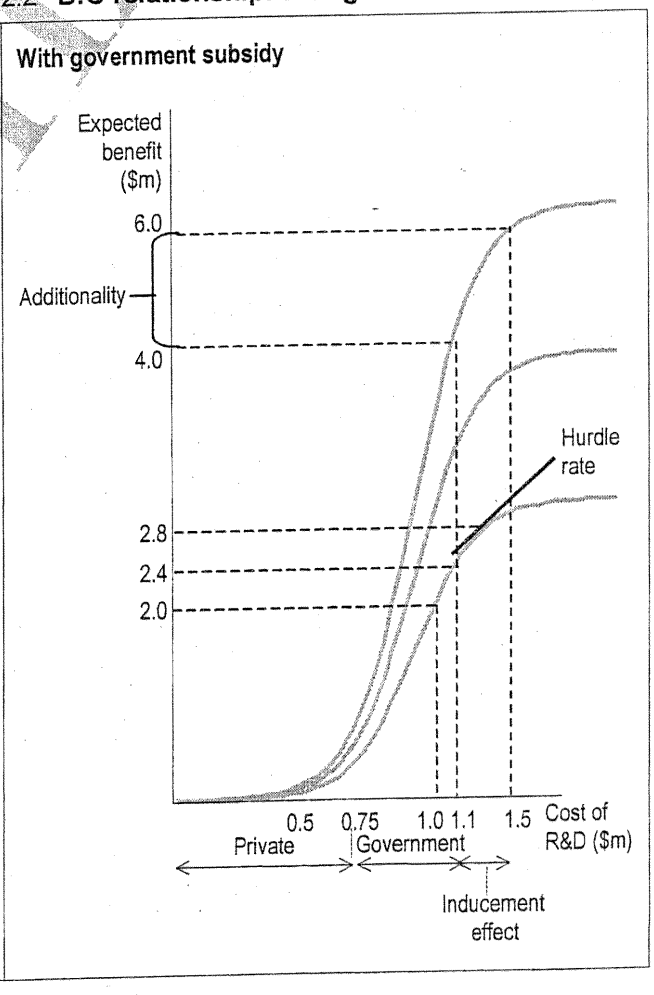
An efficient capital market will take account of private and flow-on effects

An efficient private capital market will invest in R&D up to the point where the marginal private benefit to marginal cost ratio is equal to the same benefit to cost ratio in an alternative investment (the firm's hurdle rate). In chart 2.1, this might occur at about $1.1 million invested. This would provide a private benefit of around $2.4 million, a 2.2:1 benefit to cost ratio.

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



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



Data source: CIE model.

It would also provide a flow-on benefit of $0.6 million, bringing the total market-mediated benefit to $3 million.

Flow-ons will help determine the optimal private level of investment

The expected distribution of market-mediated benefits, private plus flow-ons, should in a broad sense represent the optimal share that induces the firm to invest, customers to buy and competitors to be sufficiently disadvantaged to maintain the investor's incentive to proceed. It will be expected that through various market-mediated interactions, including the use of patents and other mechanisms to protect intellectual property, that this will be resolved. By definition, the distribution of remaining benefits will relate to spillovers.

Spillovers will not affect the private level of investment

Spillover benefits worth an additional $1 million will be generated, giving a social benefit to cost ratio of 4:1 to the wider economy.

At a 4:1 benefit to cost ratio, it may pay society to invest in more R&D. Should the government offer matching funds to the investing firm, this would halve the marginal cost of doing extra R&D and the firm would expand its R&D spending up to the point where the marginal benefit to marginal cost ratio again reached the firm's hurdle rate. In chart 2.2, this might occur at about $1.5 million.

Only part of the R&D subsidy will induce extra R&D: inducement effect

With matching funds, the firm could afford to reduce its overall financial commitment to the project, from $1.1 million down to $0.75 million. The government would provide the other $0.75 million.

- The net increase in R&D spending would not be the full government investment, but the $0.4 million indicated in chart 2.2 — the net inducement effect.
- A direct subsidy transfer of $0.35 million would go to the R&D firm.
- The firm's average benefit to cost ratio would climb from 2.2:1 to 3.7:1 ($2.8 million : $0.75 million).
- The social benefit to cost ratio would remain at around 4:1 ($6 million : $1.5 million), but the additional national benefit ($6 million - $4 million = $2 million) relative to the additional social cost ($0.4 million = $0.75 million - $0.35 million transfer subsidy) would be 5:1— a worthwhile investment.

The scenario above illustrates how provision of more funding than necessary for R&D can occur. The decision by the government to offer matching funds, as opposed to providing only what the firm needed to reach its hurdle rate, allowed the firm to spend $0.35 million less of its own funds on R&D. It is questionable whether it is appropriate for taxpayer funds to be provided to firms for R&D they were planning on conducting anyway. However, in practical terms this may be difficult to avoid.

Additionality and the benefits and costs of the R&D Start program

It is the additional marginal benefits for the Australian economy (additionality effect) caused by the contribution of the induced R&D, relative to its cost (government investment minus the transfer subsidy — the transfer is not a resource cost) that will determine the efficiency of the R&D Start program.

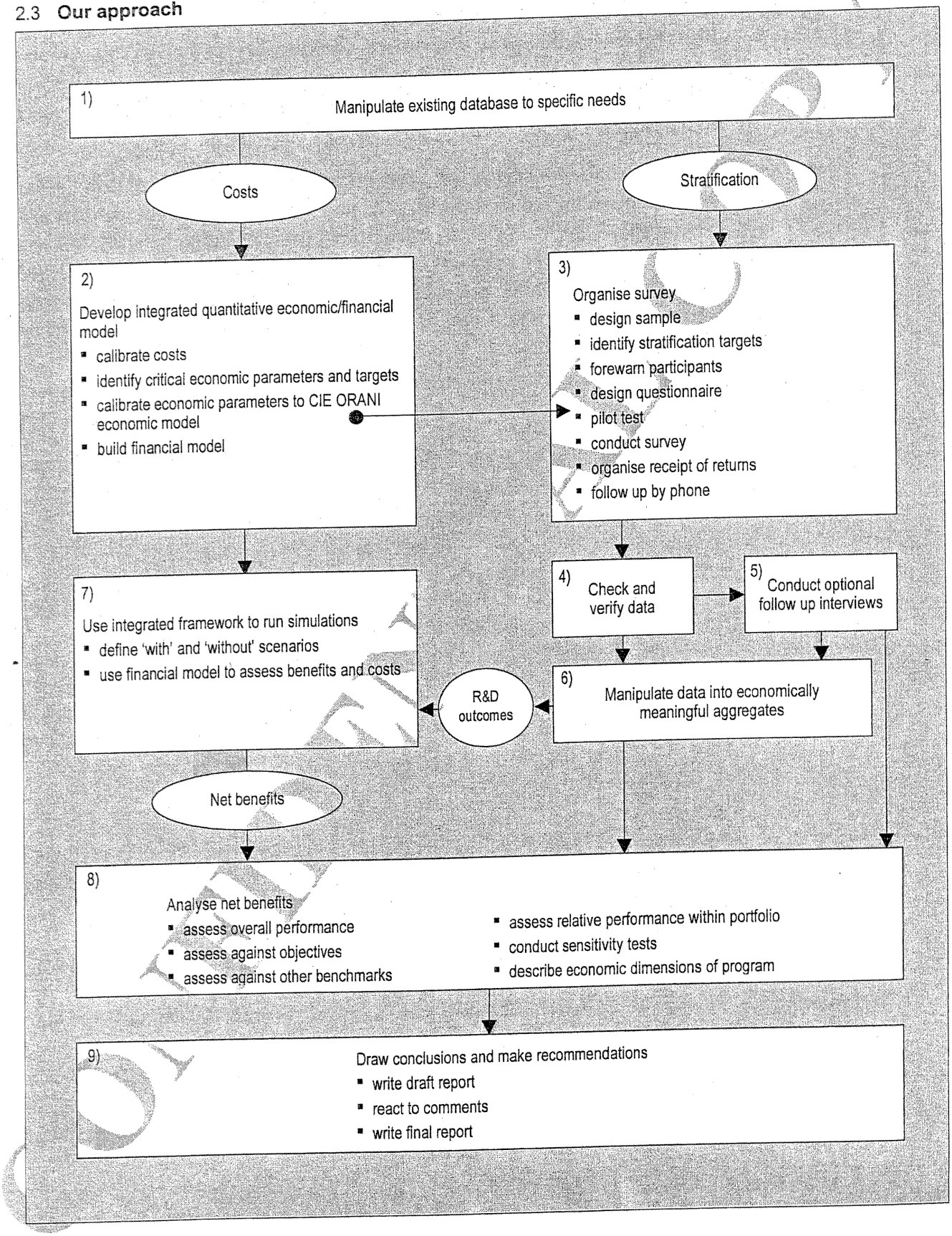
Spillovers of themselves are not an argument for government intervention

The mere existence of possible spillover benefits in a potential R&D project does not necessarily imply that government intervention will be efficient or that it is necessary to achieve those spillover benefits. If private and concomitant flow-on benefits are large enough, the R&D will be funded by the private sector and the spillover benefits will be gratuitous. If the government is to fund R&D, it must focus on providing funds to R&D that would **not** go ahead without government support. This ensures that government funding increases the total level of R&D, creating additionality.

If a government provides R&D funding to all firms conducting R&D, rent seeking behaviour among researchers will occur. Researchers who can easily fund the R&D themselves with additional or future cashflows will apply for government funding and use their own funds for other expenditure. The lower the marginal returns from additional R&D (the higher up a firm is on the private benefit curve in chart 2.1), the lesser the inducement effect shown in chart 2.1. If all grant recipients are organisations who would have largely funded the R&D themselves, then the less the additional R&D created from the R&D Start subsidy. If, on the other hand, funding is directed to R&D with good potential spillover benefits that will not go ahead without assistance, additional R&D occurs from government funding.

By and large, spillover benefits must also occur in Australia to benefit Australians. So it is necessary to account for leakage of spillovers abroad.

2.3 Our approach



The broad approach in this review

This review develops a framework for measuring the overall national benefits and costs from R&D Start supported R&D. The approach is discussed in detail in appendix A. Chart 2.3 lays out our general approach to the review.

A comprehensive survey of Start recipients was conducted to collect detailed quantitative data on benefits and costs, R&D inputs, outputs and outcomes — appendix B. To determine private, flow-on and spillover economic impacts of the R&D, survey data was aggregated and analysed using the CIE's ORANI model of the Australian economy and other models where necessary. In addition to this, five case studies were conducted on Start program applicants.

3 Overview of survey results

The original terms of reference called for a survey of Start recipients and a control group. In consultation with the Department, the only identifiable control group was considered to be non-recipients. In total, 474 Start applicants were sent the survey. About 140 recipients and 58 non-recipients responded to the survey within two weeks of receiving the questionnaire. This represents a 42 per cent response rate. Based on several key parameters, the sample appears to provide a good representation of the population (appendix C).

However, the control group has been withdrawn based on advice to the Department from a major surveying company and a statistical analysis agency. The verdict:

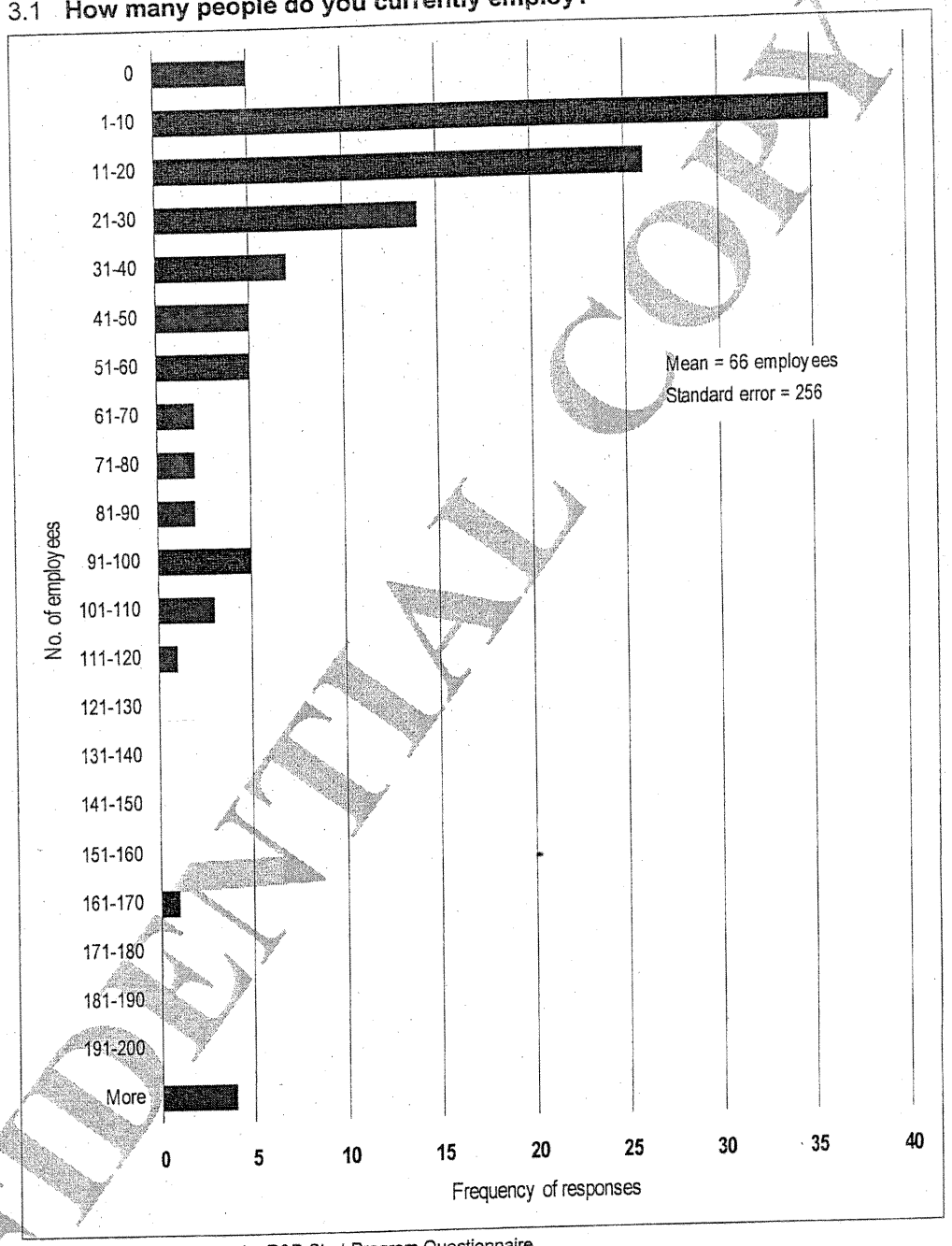
- 'the model used by your consultants does not appear to be a control group';
- 'the control group was unlikely to be representative of the broader population';
- 'the group will have significant bias risks'; and
- 'it is likely to differ in important ways from the recipients'.

Here, only the findings of recipients are reported.

Part 1 responses: broad dimensions of survey respondents

The following charts summarise key elements of the grant recipients.

3.1 **How many people do you currently employ?**



Data source: Responses to the R&D Start Program Questionnaire.

Applicants are typically small to medium sized, Australian owned, private companies

Employment is generally less than 40 people

Recipients typically have fewer than 40 employees and the most likely situation (the modal situation) is that they will have between 0 and 10

employees (chart 3.1). However, larger firms with more than 200 employees are represented.

Turnover is typically less than $3 million a year

As for employment, the mean turnover of the recipient group is inflated by the small number of very large firms. The most likely (modal) situation is that recipients will be firms with $1 million a year turnover – chart 3.2.

Indicators of impacts of Start

Additional employment and R&D expenditure by recipients

Grant recipients indicated that on average they employed an additional four people since finishing their R&D Start supported project – chart 3.3. Spending is centred around $1 million a year –chart 3.4.

Collaboration

Mostly, recipients undertake their R&D without collaborators. Around 24 per cent of recipients involved collaborators in their R&D. Of firms using collaborators, recipients distribute their collaboration fairly evenly between the categories listed in chart 3.5.

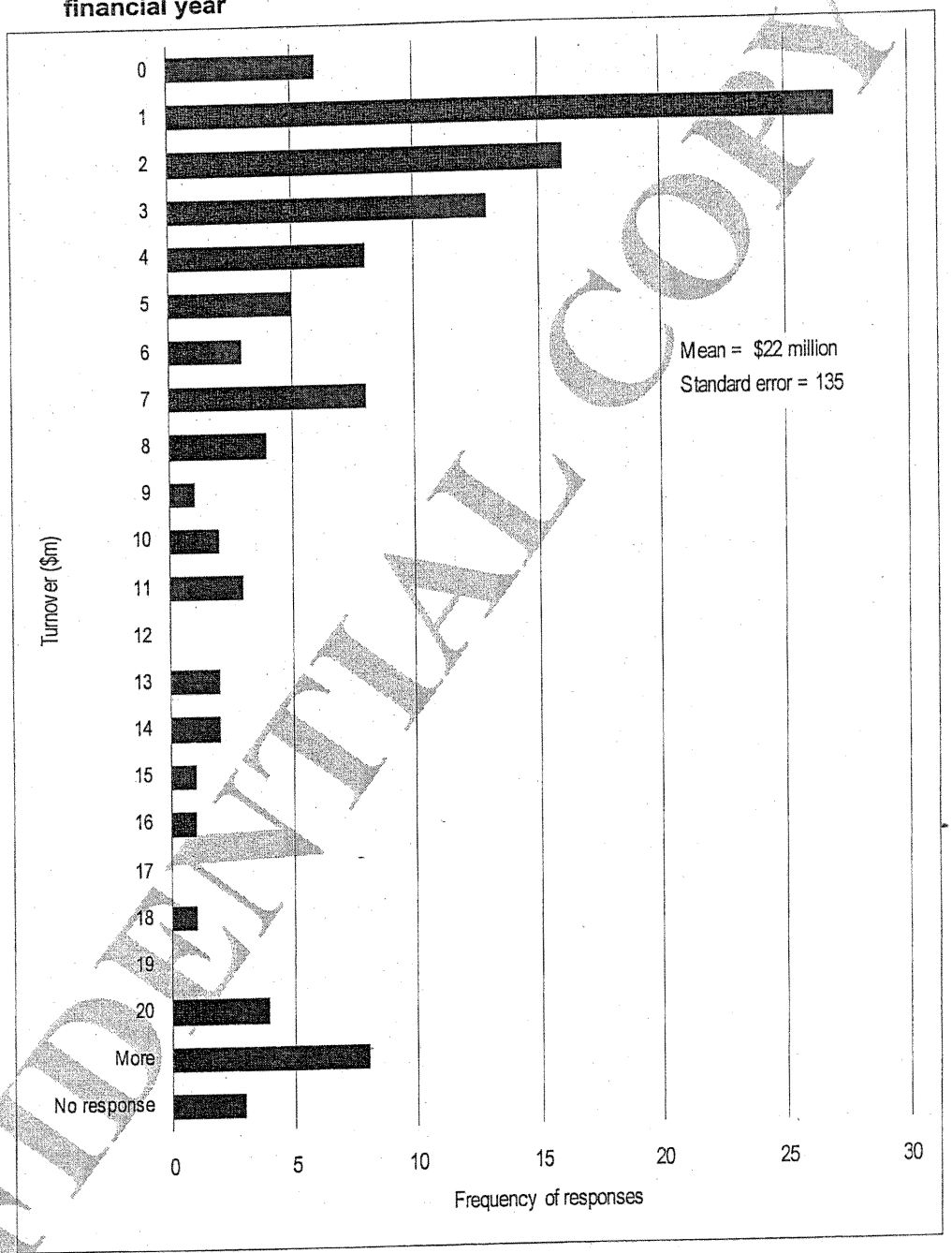
Low proportions of R&D funding go to plant and equipment

On average, about 15 per cent of total R&D spending was allocated to plant and equipment, indicating that most was used to fund wages and salaries of researchers (chart 3.6).

Part 2 responses: R&D expenditure and stages

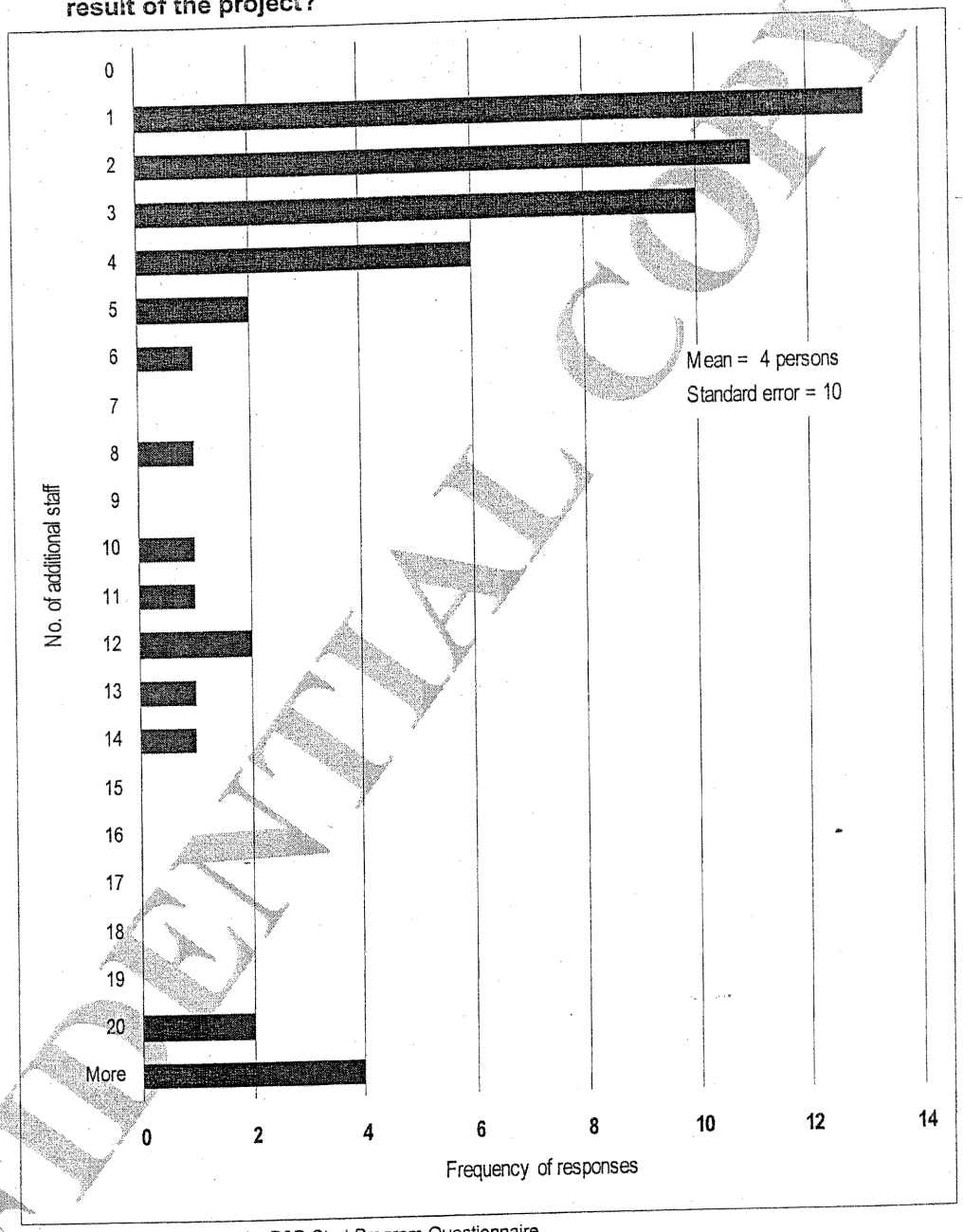
In the recipient group, most R&D expenditure to date has been in developing a prototype – chart 3.7. Commercialisation and market development are indicated to involve lesser Start funds and overall investment, and in many cases these investments are yet to occur.

3.2 Please indicate the turnover (total revenue) of your firm during 2001-02 financial year



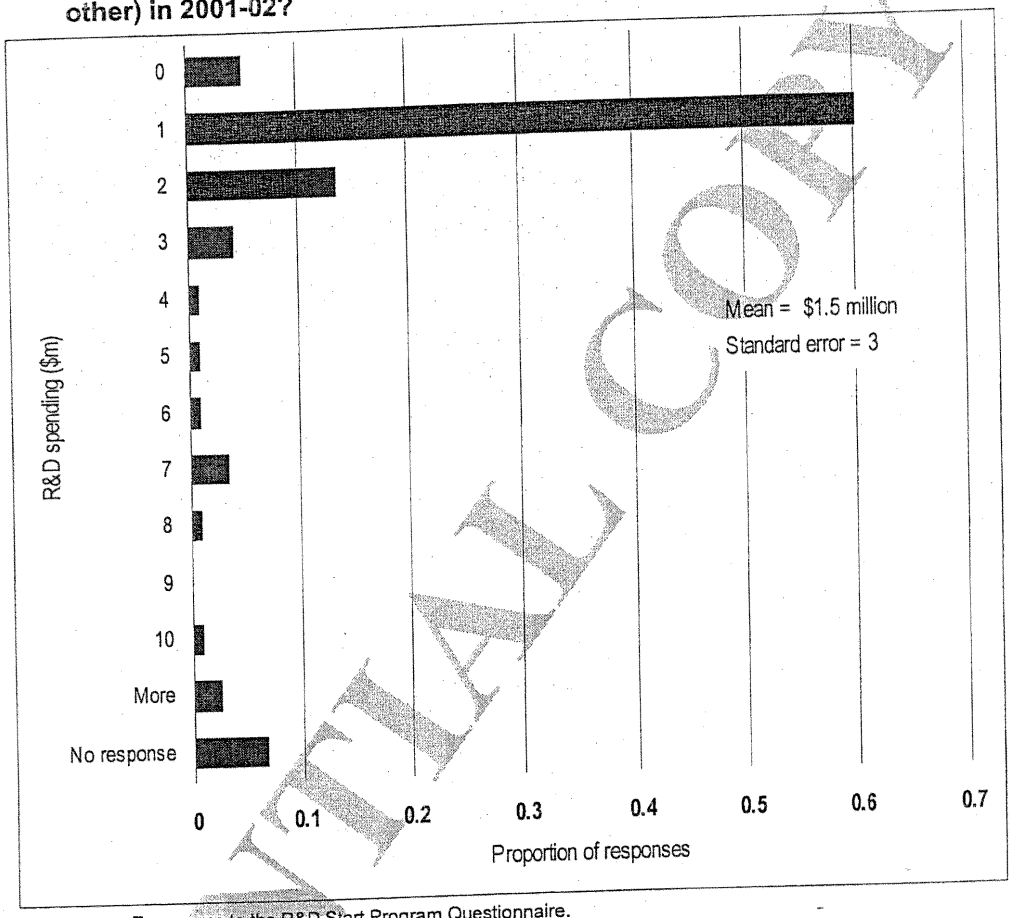
Data source: Responses to the R&D Start Program Questionnaire.

3.3 Since completing the project have you employed additional staff as a result of the project?



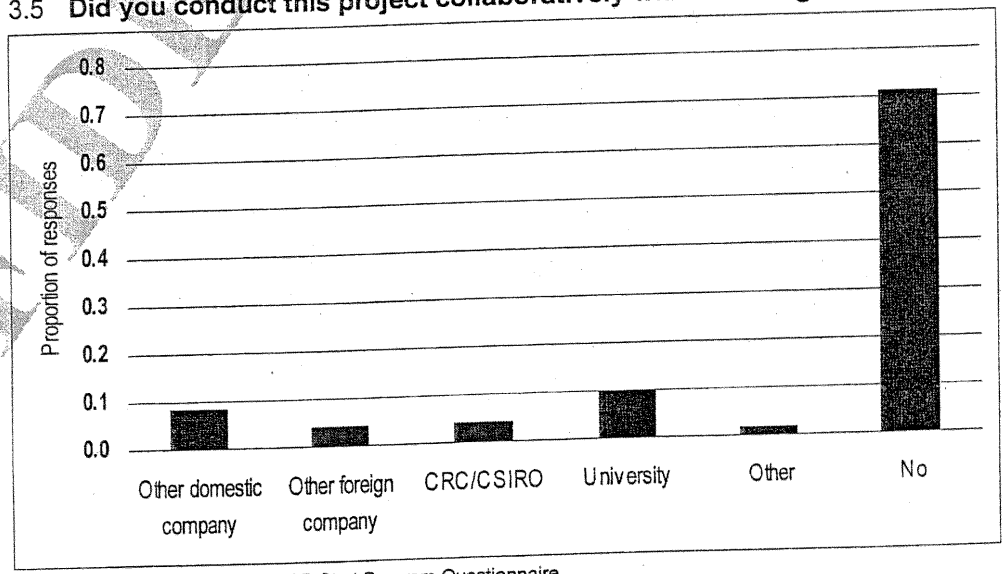
Data source: Responses to the R&D Start Program Questionnaire.

3.4 How much did you spend on R&D in total (R&D Start project plus any other) in 2001-02?



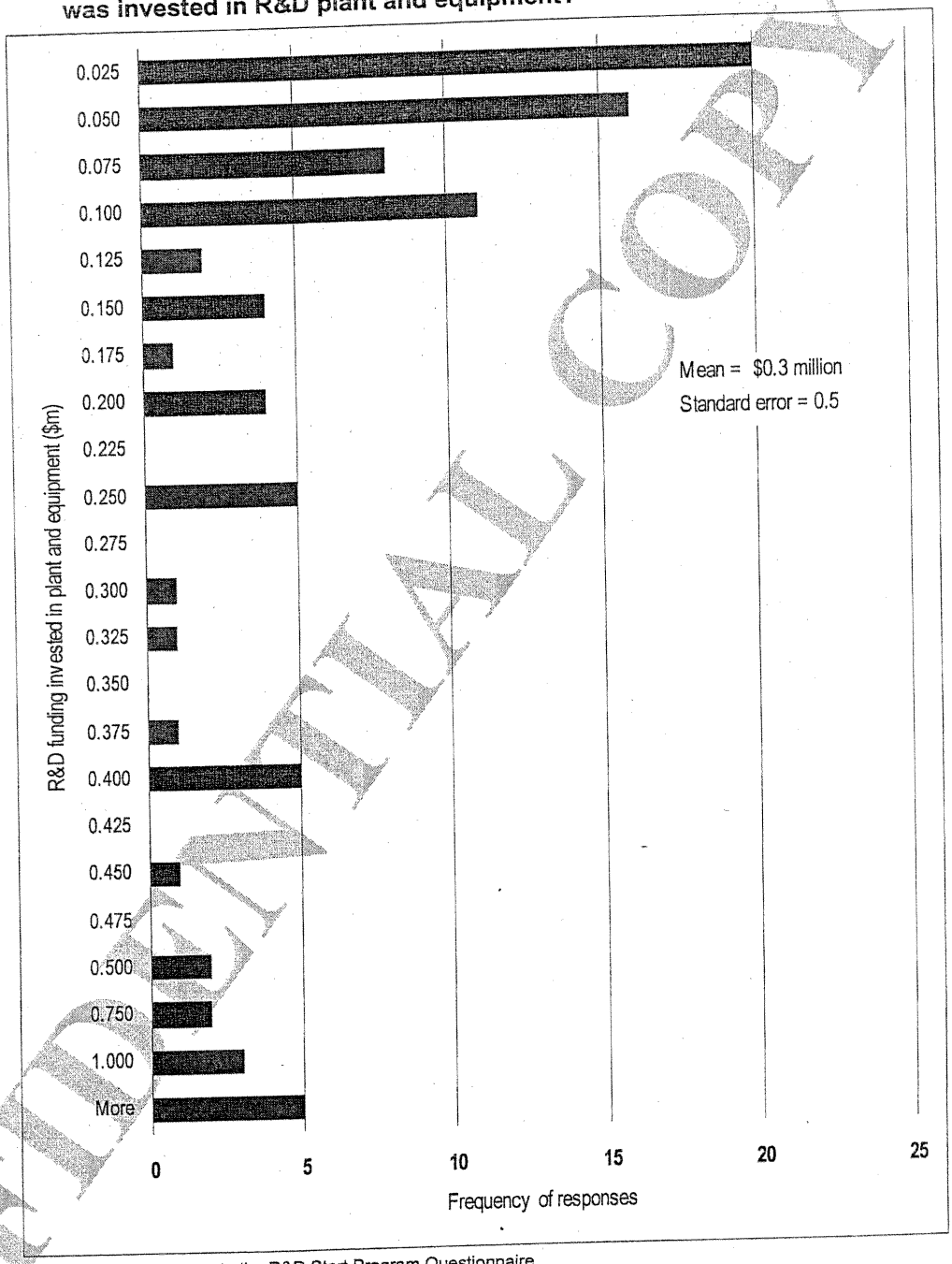
Data source: Responses to the R&D Start Program Questionnaire.

3.5 Did you conduct this project collaboratively with other organisations?



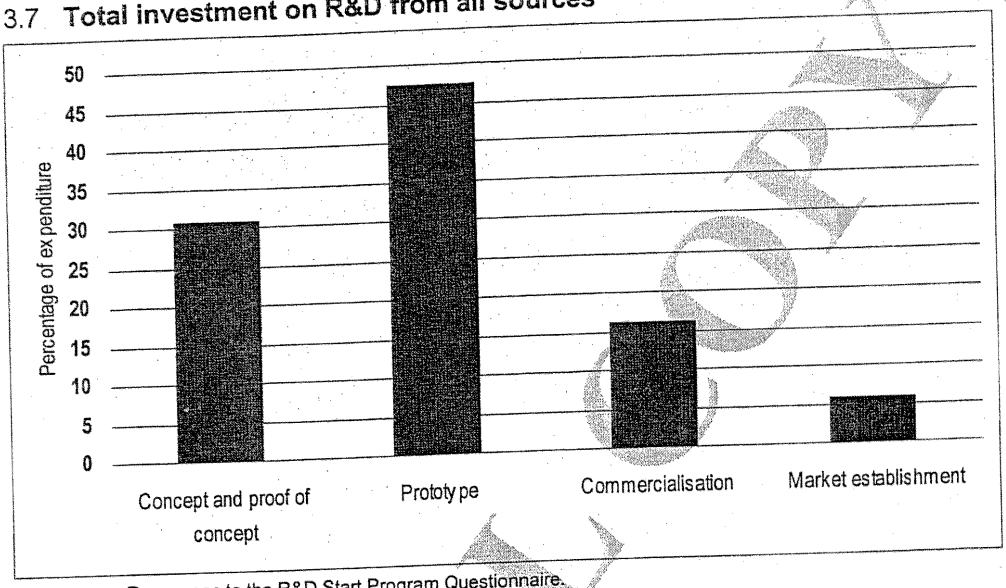
Data source: Responses to the R&D Start Program Questionnaire.

3.6 How much of the total R&D funding for the R&D Start-related project was invested in R&D plant and equipment?



Data source: Responses to the R&D Start Program Questionnaire.

3.7 **Total investment on R&D from all sources**



Data source: Responses to the R&D Start Program Questionnaire.

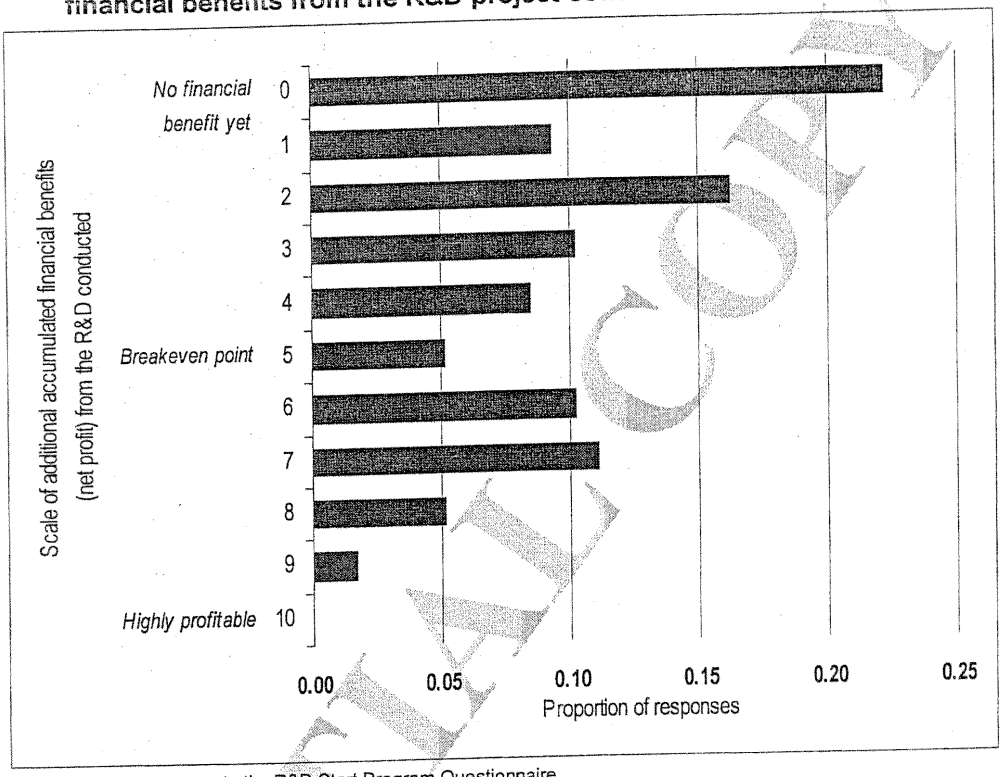
Part 3 responses: respondents' beliefs about future profitability

Most companies (72 per cent recipients) indicated their R&D projects have not yet established a profitable operation. They are at or below their breakeven level — chart 3.8. However, most are highly optimistic about the future. Ten years from now, 85 per cent of recipients believe that their R&D projects or alternative ventures will be either profitable or highly profitable — chart 3.9.

Part 4 responses: economic outcomes, flow-ons and spillovers

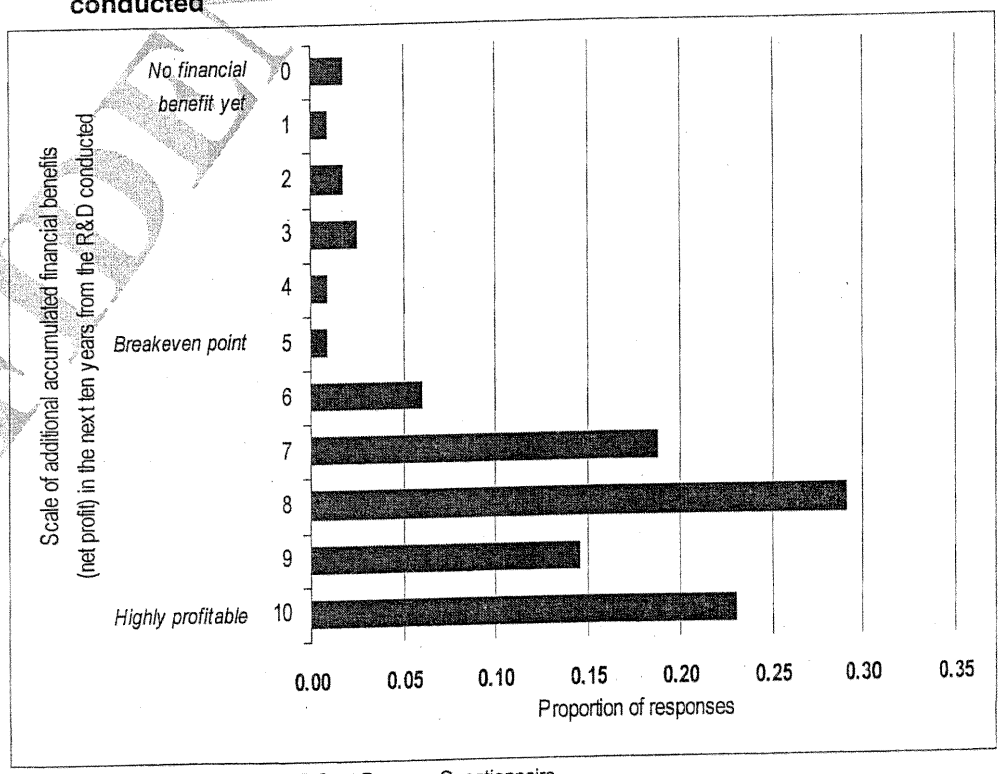
Among recipients, the main economic impact of the R&D was indicated to be the development of a new or better product, service or process — chart 3.10. About 50 per cent of respondents selected these categories. Fewer companies indicated the development of technology to reduce their costs. About a quarter of respondents indicated increased intellectual property as a main economic impact. Around 20 per cent indicated that the increased opportunity for them to engage in new ventures or collaboration was also an important economic impact.

3.8 The extent to which your company has received additional accumulated financial benefits from the R&D project conducted



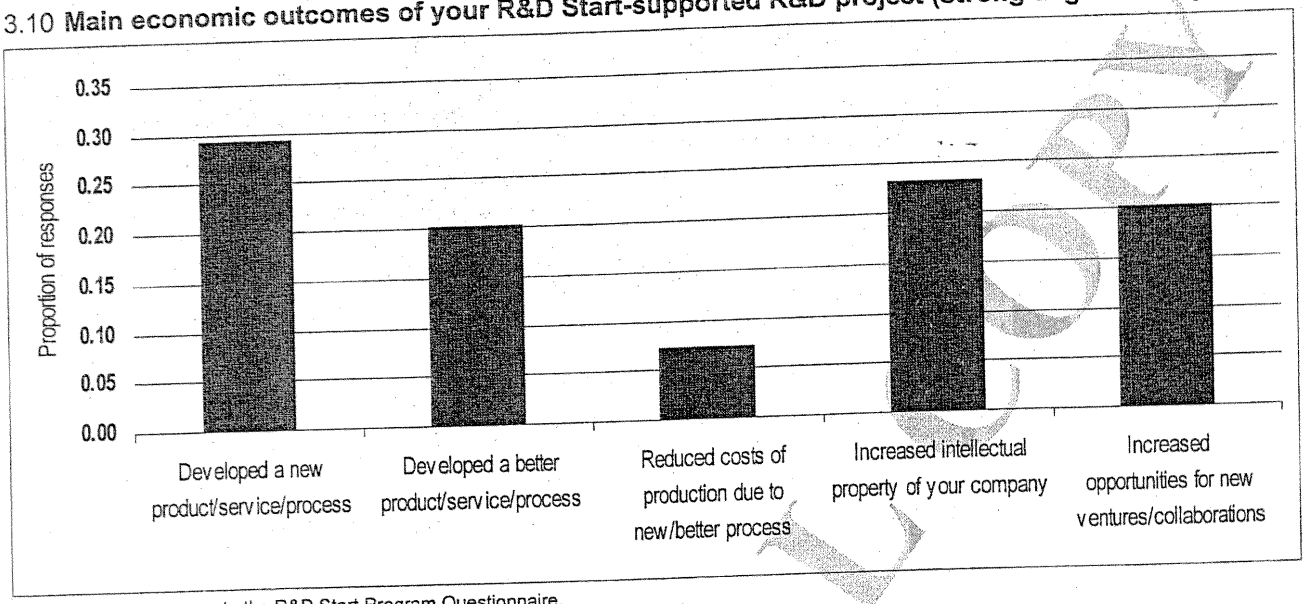
Data source: Responses to the R&D Start Program Questionnaire.

3.9 The extent to which you expect your company to receive additional financial benefits (net profit) in the next ten years from the R&D project conducted



Data source: Responses to the R&D Start Program Questionnaire.

3.10 **Main economic outcomes of your R&D Start-supported R&D project (strong degree of impact)**



Data source: Responses to the R&D Start Program Questionnaire.

Products

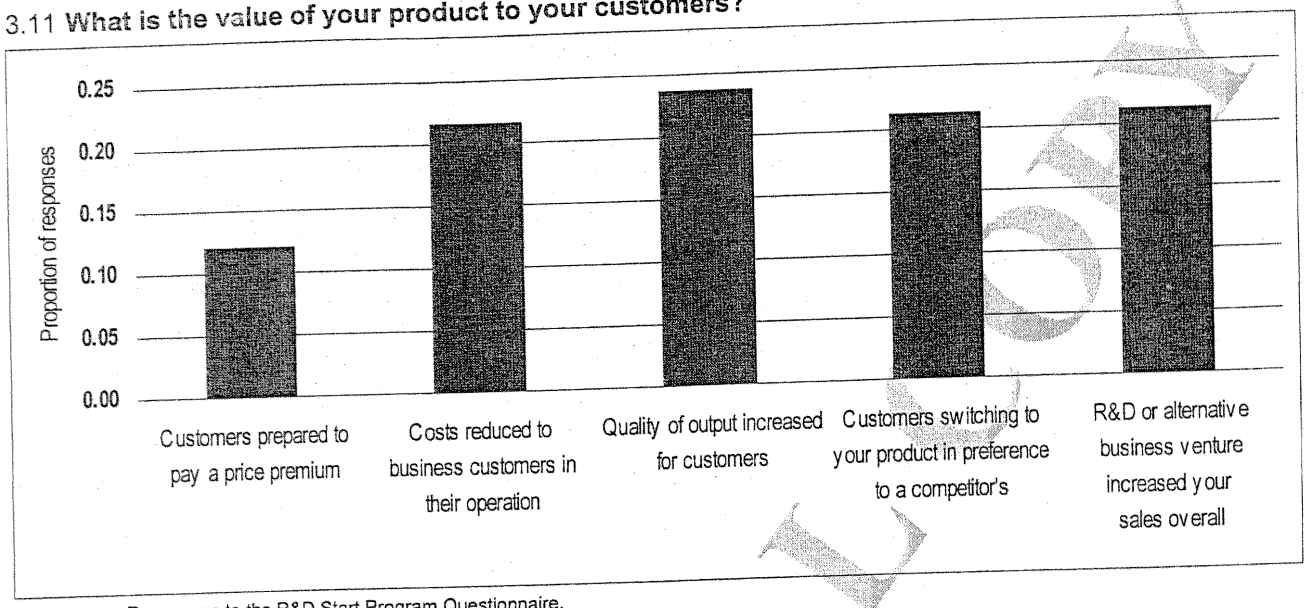
For business customers and export oriented

The new or better products being developed by R&D Start recipients are almost entirely for business customers rather than households. Also, they are mainly destined to the export market five years from now (74 per cent, and 26 per cent to the domestic market). Nearly a third of respondents did not attempt this question on market shares, perhaps reflecting the uncertainty of future markets.

Expected to deliver significant benefits to business customers

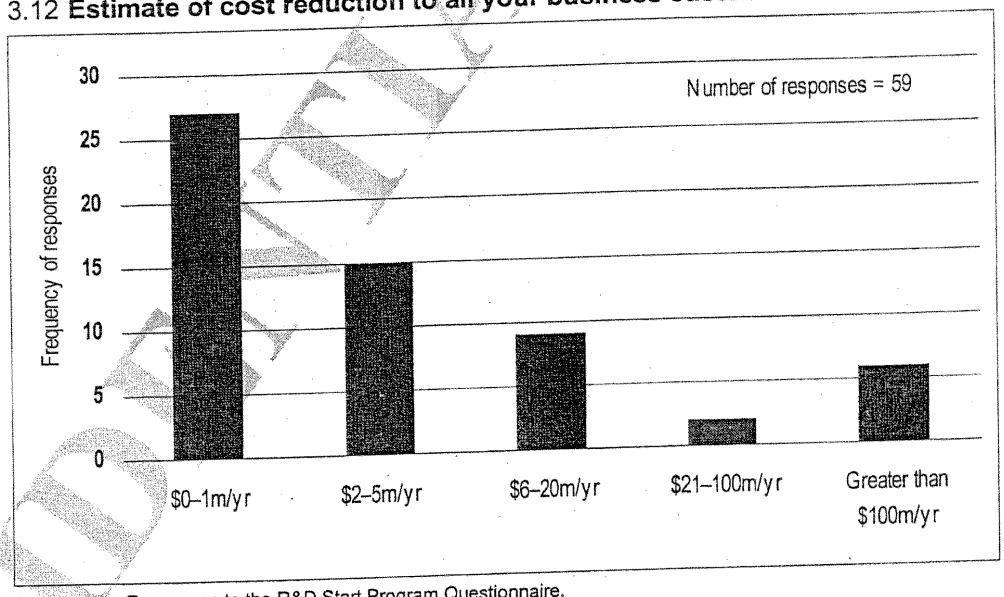
New and better products are expected to deliver benefits to the customers of recipients in the ways indicated in chart 3.11. Of those respondents who specified that their products would lower their customers' costs of doing business, the weighted average estimated value of the products to customers is around $20 million per firm. However the distribution is highly skewed with most firms expected much smaller benefits of around $1 to 5 million a year – chart 3.12.

3.11 **What is the value of your product to your customers?**



Data source: Responses to the R&D Start Program Questionnaire.

3.12 **Estimate of cost reduction to all your business customers**



Data source: Responses to the R&D Start Program Questionnaire.

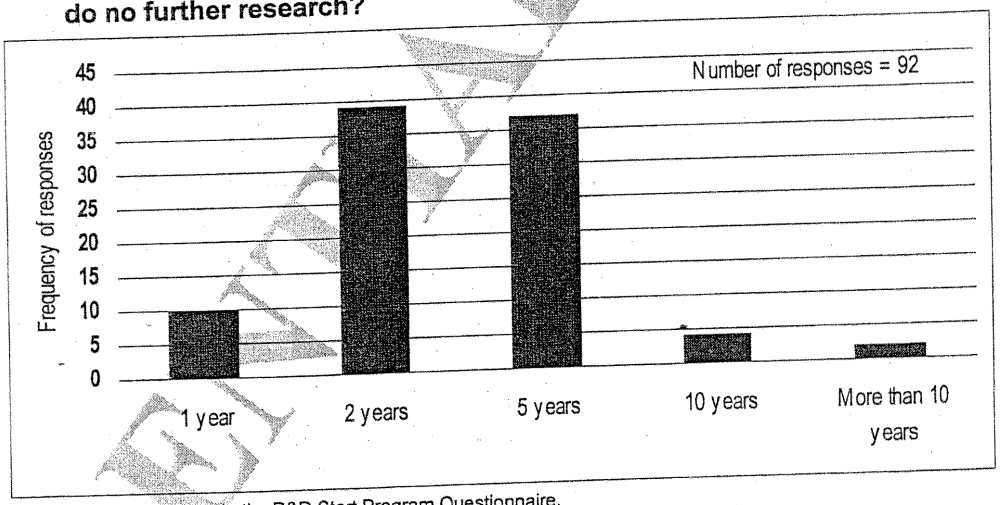
Recipients expected to be able to retain their competitive edge

Charts 3.13, 3.14 and 3.15 indicate that respondents expect to be able to retain the competitive edge their R&D will confer provided they maintain ongoing R&D. Nonetheless, there is also some expectation implicit that either their technology will quickly diffuse through the industry they compete in or the technology they have developed is not highly novel or unique, and others will be able to develop competitive, substitute technologies. Interestingly, two thirds of those who responded indicated that further government assistance — chart 3.15 — would be required to allow them to maintain their competitive edge.

Lower costs of production for recipient firms

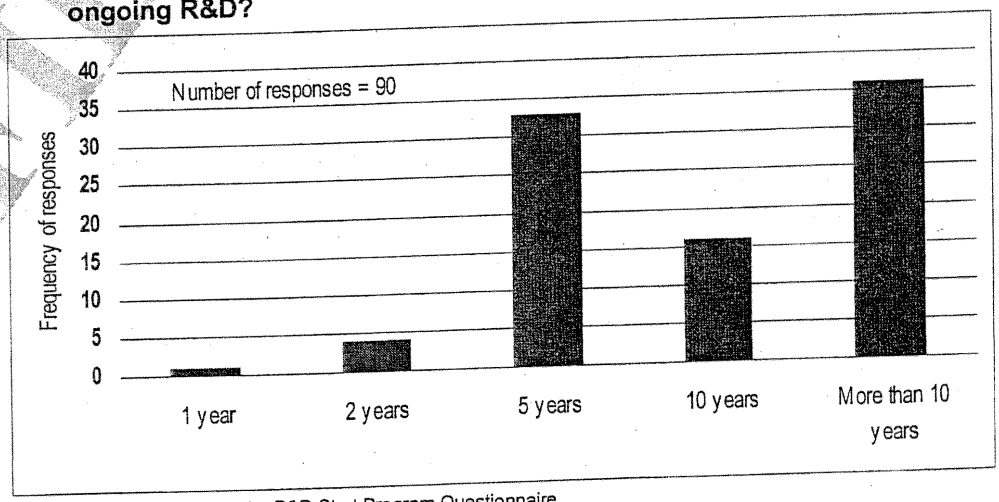
Of those firms whose technology focuses on lowering their own costs of production, respondents indicated a weighted average expected cost reduction of 15.5 per cent – chart 3.16 About half of the respondents expected that their technology would be applicable to the entire industry and thought they would reasonably quickly lose their competitive edge with this technology, without more R&D – charts 3.17 and 3.18. Ongoing R&D could delay their declining competitive edge, but not for as long as for those recipients developing new or better products – chart 3.19. As with those developing new and better products, about two thirds of respondents indicated that they did not expect to be competitive without further government assistance to develop more R&D – chart 3.20.

3.13 How long before you lose your competitive edge to rivals, assuming you do no further research?



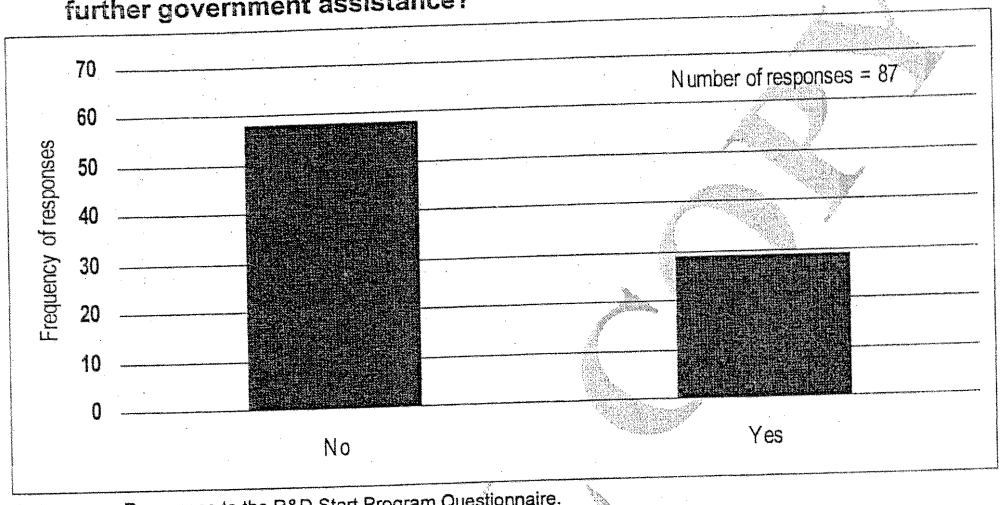
Data source: Responses to the R&D Start Program Questionnaire.

3.14 How long before you lose your competitive edge to rivals, assuming ongoing R&D?



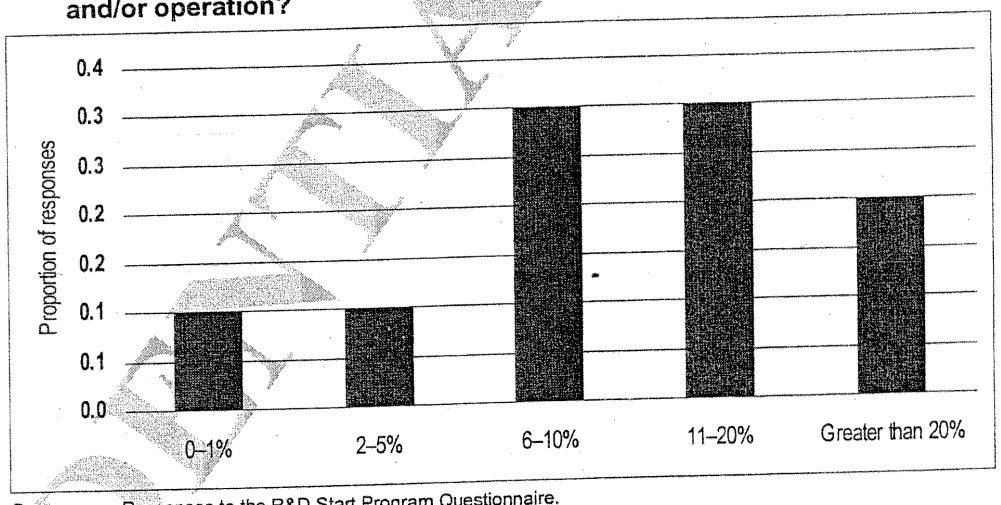
Data source: Responses to the R&D Start Program Questionnaire.

3.15 Is ongoing R&D to maintain your competitive edge sustainable without further government assistance?



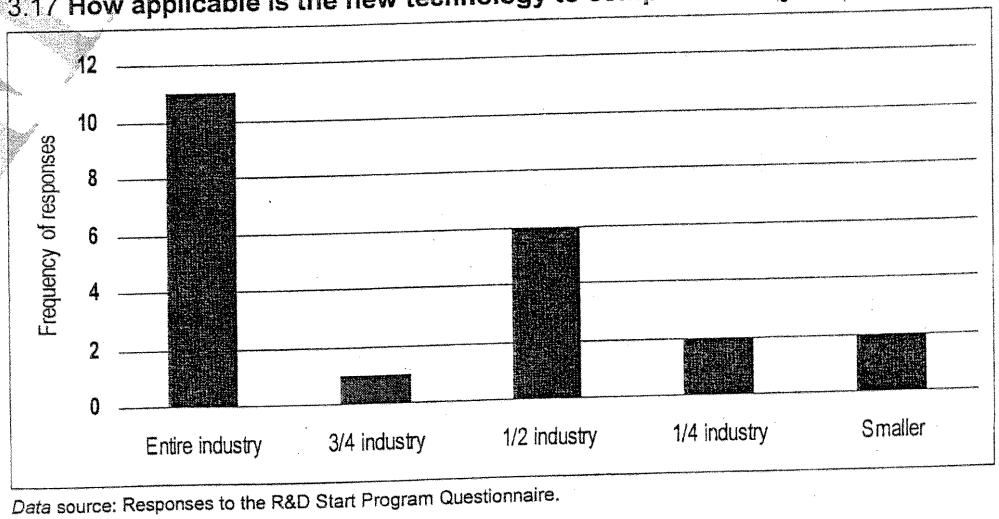
Data source: Responses to the R&D Start Program Questionnaire.

3.16 How much has the new technology lowered your costs of production and/or operation?



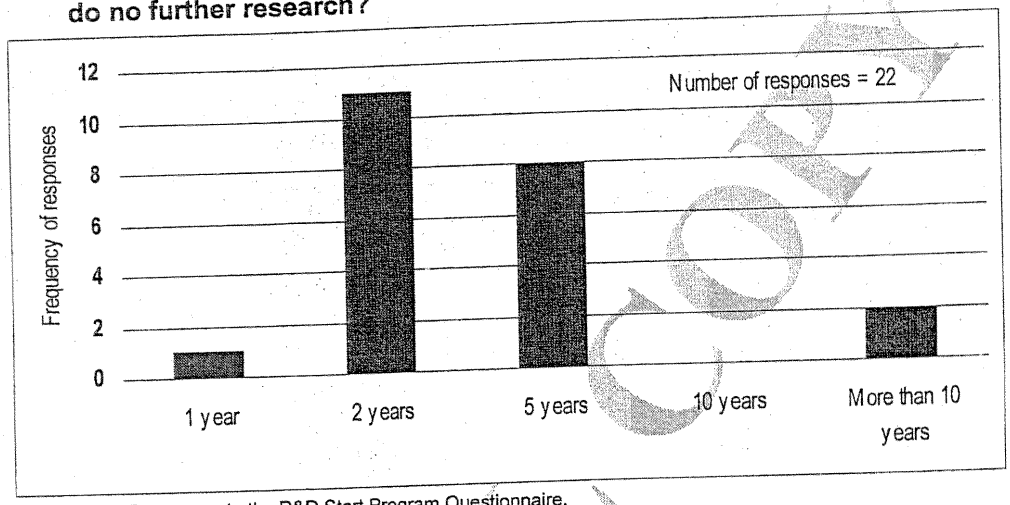
Data source: Responses to the R&D Start Program Questionnaire.

3.17 How applicable is the new technology to competitors in your industry?



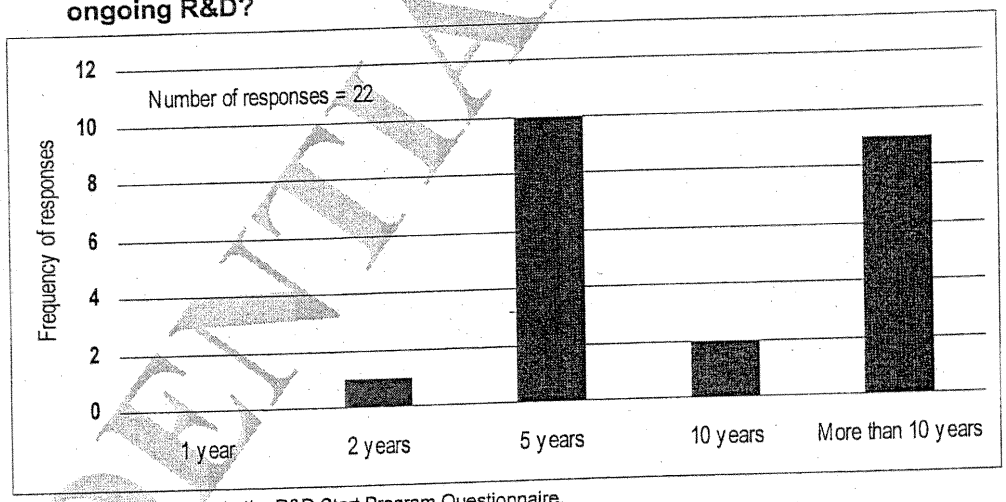
Data source: Responses to the R&D Start Program Questionnaire.

3.18 How long before you lose your competitive edge to rivals assuming you do no further research?



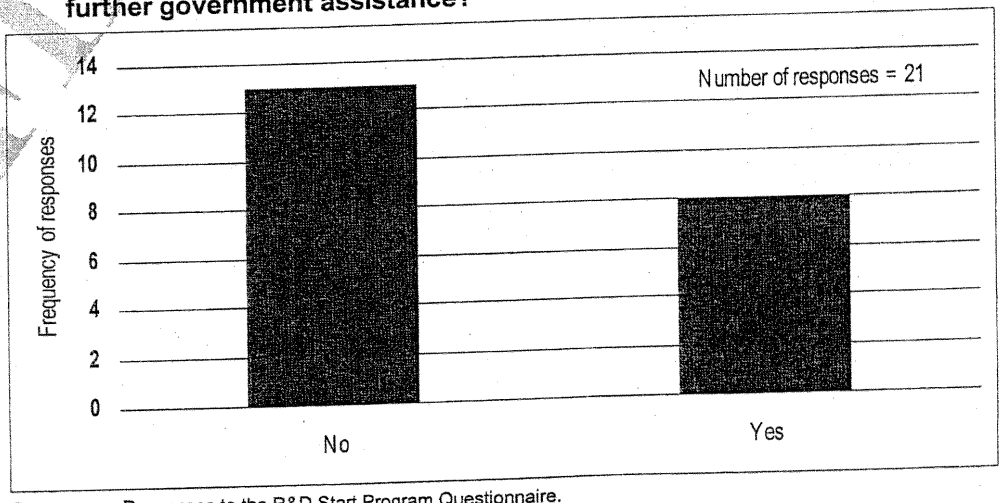
Data source: Responses to the R&D Start Program Questionnaire.

3.19 How long before you lose your competitive edge to rivals assuming ongoing R&D?



Data source: Responses to the R&D Start Program Questionnaire.

3.20 Is ongoing R&D to maintain your competitive edge sustainable without further government assistance?



Data source: Responses to the R&D Start Program Questionnaire.

Strong intellectual property protection

Over half (57 per cent) of the grant recipients who responded indicated that they had at least one way of protecting their IP. Most indicated that they had several means of protecting their IP — chart 3.21.

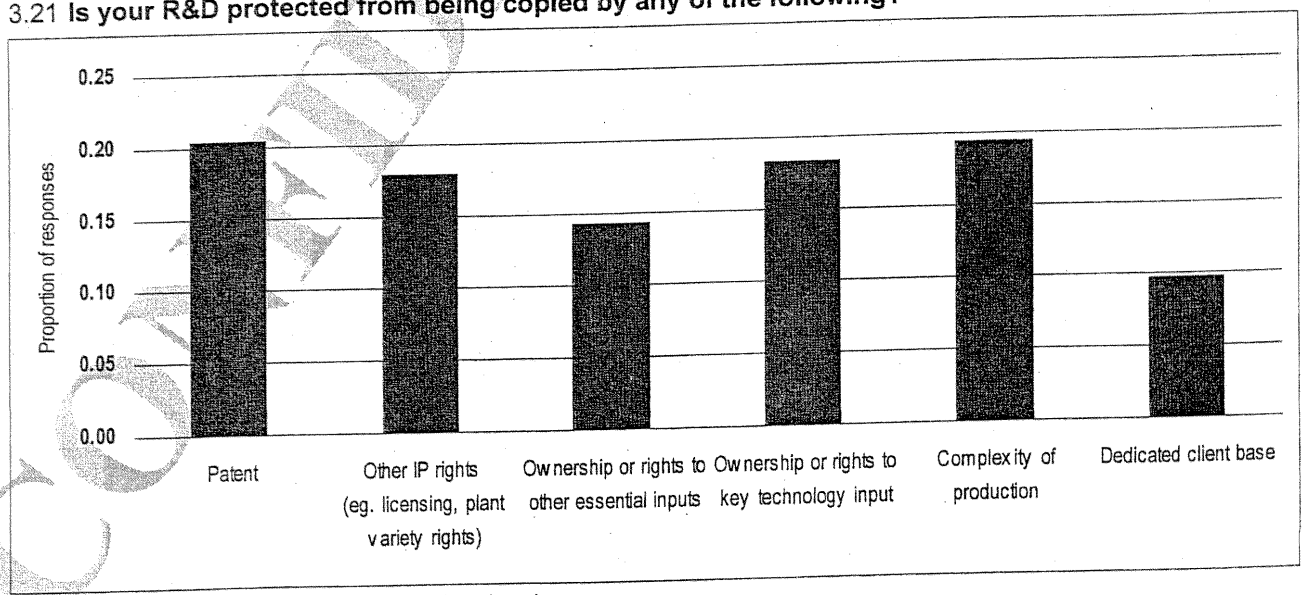
New business ventures and collaborations

Mostly, new ventures were centred on opportunities to develop markets — chart 3.22.

Other economic impacts

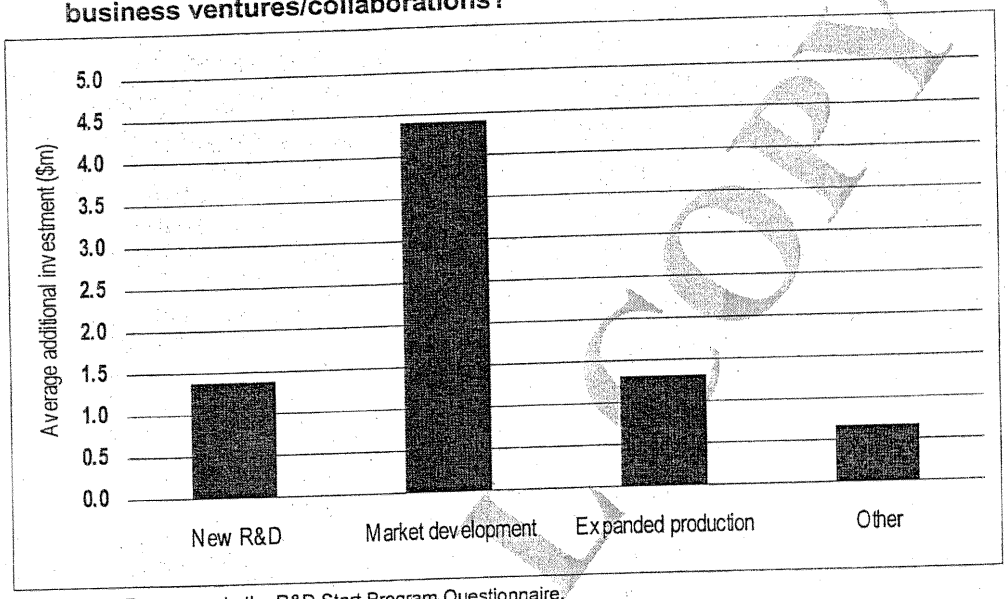
Over half the recipients who responded indicated an increase in the skills of their employees and the development of a platform technology as significant economic flow-ons to their own firms — chart 3.23. Generally all other flow-on impacts and impacts on other parts of the economy are considered significant by between 10 and 20 per cent of respondents.

3.21 **Is your R&D protected from being copied by any of the following?**



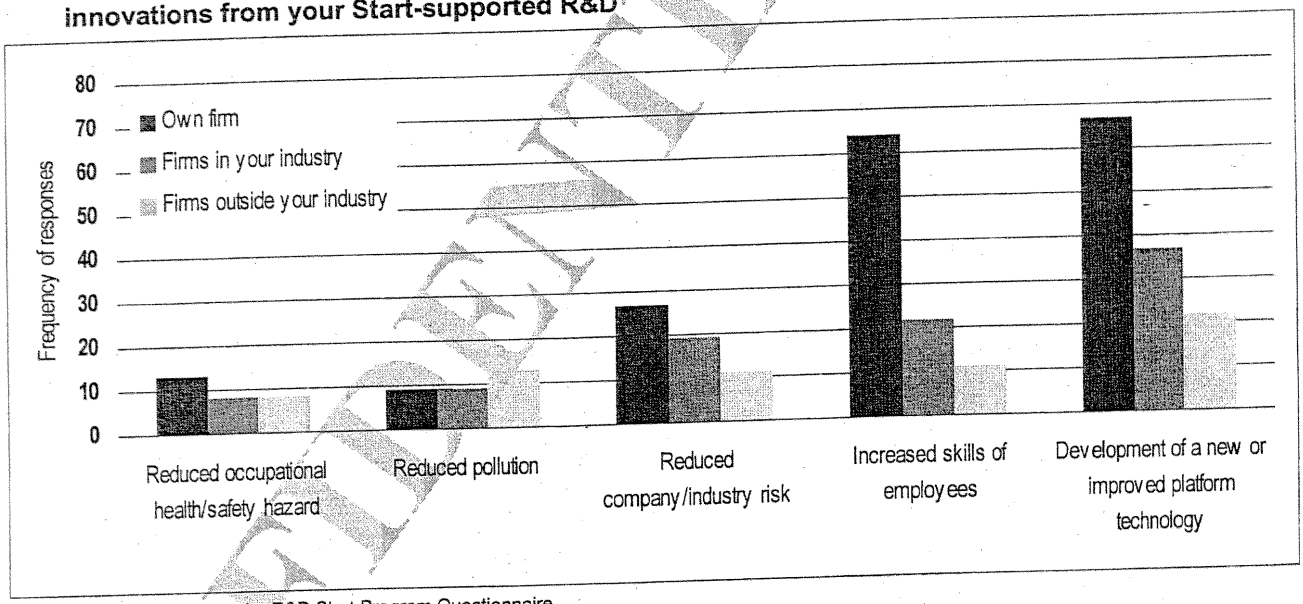
Data source: Responses to the R&D Start Program Questionnaire.

3.22 **What is the additional investment as a result of these further R&D and/or business ventures/collaborations?**



Data source: Responses to the R&D Start Program Questionnaire.

3.23 **Please indicate if there have been any other significant flow-on economic impacts or innovations from your Start-supported R&D**



Data source: Responses to the R&D Start Program Questionnaire.

Part 5 responses: firms' perceptions of R&D Start influence

The majority of recipients indicated that the receipt of R&D Start funds had a major impact on their R&D. Had they not received it:

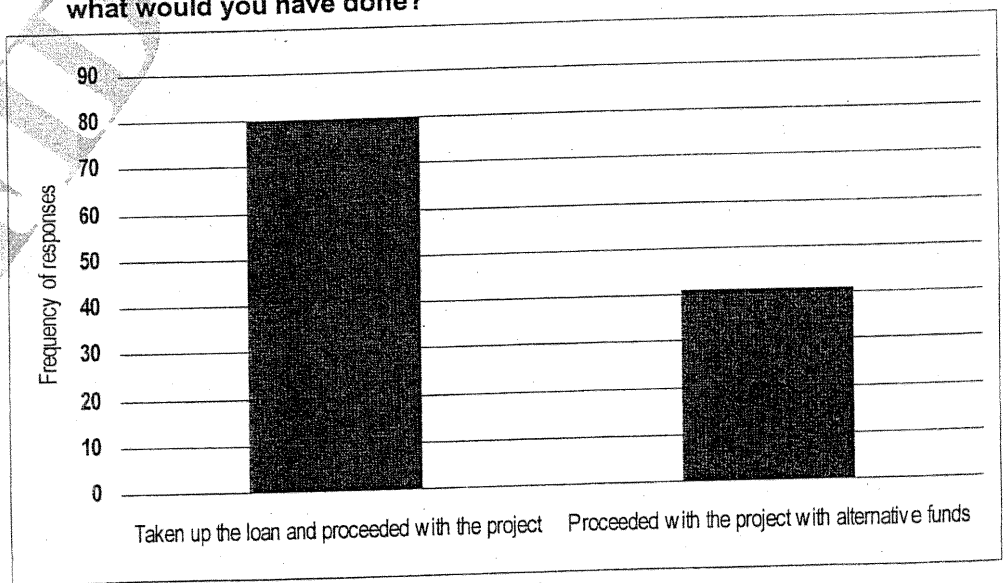
- around 80 per cent of respondents indicated that on average it would have halved the probability of success of the R&D, from around 63 to 29 per cent;
- around 80 per cent indicated that on average the scope of their exercise and its output could have also been halved;
- over 90 per cent indicated substantial delays to achieving commercialisation of an average 4.2 years;
- about 90 per cent indicated that it would have substantially increased their costs of doing the project — on average 72 per cent.

However, about a third of recipients indicated that if they had to repay their grant once the R&D was commercial and successful, they would not have accepted the funding. About a third also indicated that they would have proceeded with the project using alternative funding — chart 3.24.

Recipients also indicated that the current funds they had received were probably of greater marginal value to them than additional funds would be. Had they received twice as much R&D Start funding as they did, and with no requirement from them to make matching funding:

- 75 per cent indicated that they would have reduced their own funding by 53 per cent;
- about half indicated it would not have increased the probability of success; and

3.24 **If, instead of an R&D Start grant you had been offered a concessional loan, which was only repayable upon commercial success of the R&D, what would you have done?**



Data source: Responses to the R&D Start Program Questionnaire.

- overall time to reach commercialisation would have decreased by only about a year.

These answers are roughly consistent with responses about the adequacy of funds. About two-thirds of recipients indicated that the R&D Start funds they received were sufficient to efficiently and expeditiously conduct their R&D.

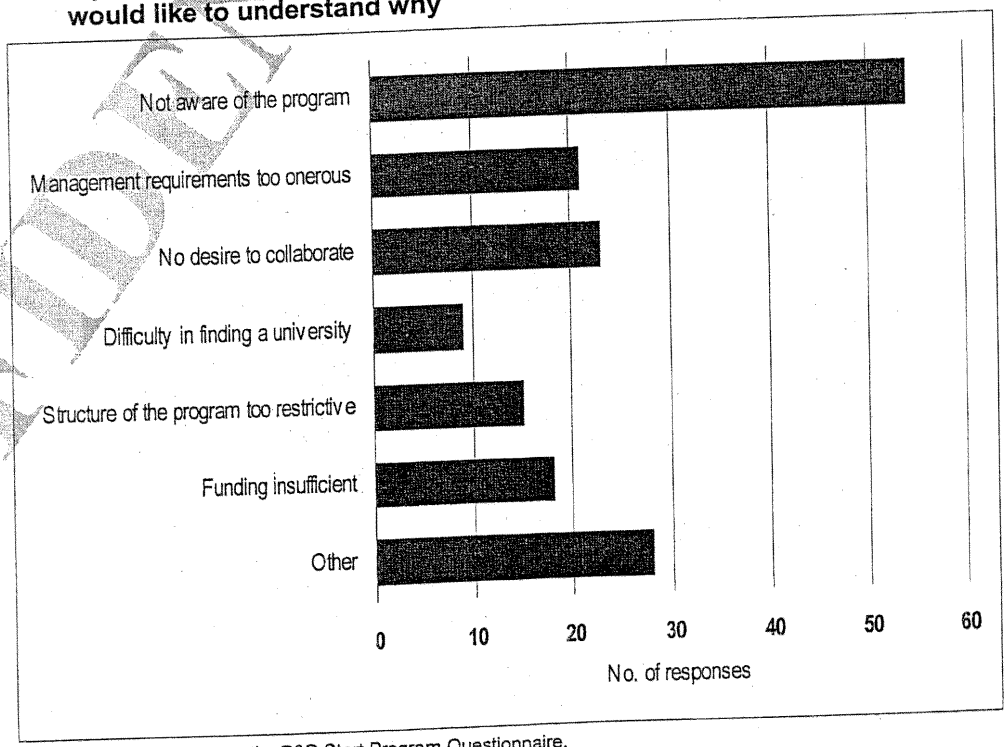
Part 6 responses: perceptions of the graduate R&D Start scheme

Only 5 per cent of recipient respondents indicated an involvement in the graduate R&D Start scheme. Of those that had not been involved in the scheme, 46 per cent indicated they were not aware of it and 20 per cent said they had no need for it. Others were generally critical of aspects of the scheme as summarised in chart 3.25.

Part 7 responses: perceptions of the loan R&D Start scheme

Only 2.5 per cent of recipient respondents indicated an involvement in the loan R&D Start scheme. Of those that had not been involved in the scheme,

3.25 If you have not been involved in the R&D Start Graduate program, we would like to understand why



Data source: Responses to the R&D Start Program Questionnaire.

about 30 per cent were unaware of it, 14 per cent did not qualify for it and the remainder chose not to take it up due to negative perceptions of it — chart 3.26.

Part 8 responses: perceptions of compliance costs

Compliance costs average $68 000, which is 8.1 per cent of total R&D Start grant funding (chart 3.27). Although not asked directly of non-recipients, many offered their views in written open-ended responses. Many complained of the tens of thousands of dollars that they had paid consultants or the time they had foregone to prepare their unsuccessful applications.

Graduate Start

The response rate for the Graduate Start survey was reasonable, with only 10 responses from a possible 26 — a response rate of 38 per cent. Despite the response rate, the small sample size makes it difficult to draw conclusions about the Graduate Start population.

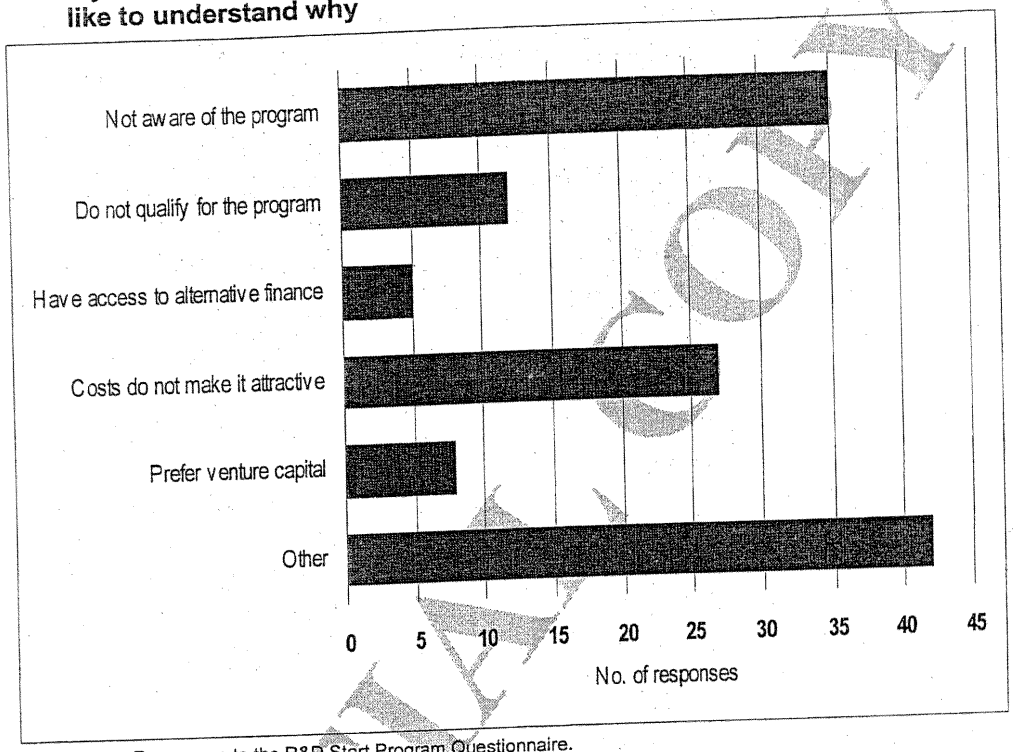
Profile of the respondents

Ninety per cent of the firms responding were private companies. The average number of employees (42) was similar to the grant respondents and reflects the same bias due to one large firm (300 employees) responding to the survey. The majority of firms were small, with less than 20 employees. The turnover pattern was also similar, with the average turnover of $6.8 million reflecting the large firm in the sample, and most firms in the zero to $3 million turnover category.

Involvement with other R&D programs

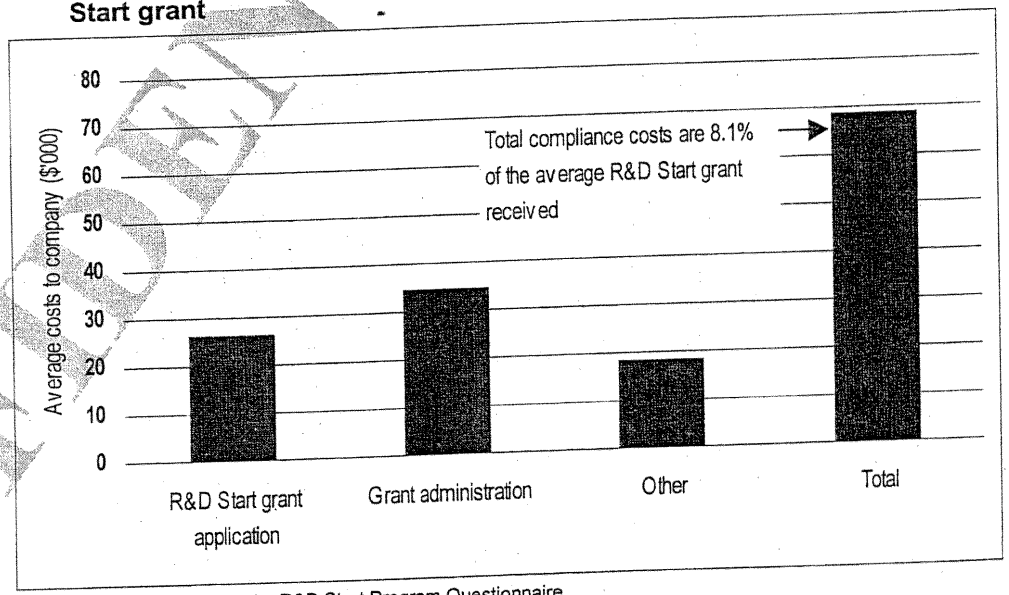
Forty per cent of the firms had received an R&D Start grant prior to involvement in the Graduate program and for one firm it was the second time they had participated in the Graduate program. This compares with 42 per cent of grant respondents having received some form of government assistance for R&D prior to current participation in Start, of which only 20 per cent had received a Start grant before.

3.26 If you have not been involved in the R&D Start Loan program, we would like to understand why



Data source: Responses to the R&D Start Program Questionnaire.

3.27 Please provide your best estimate of the costs to your company in meeting the requirements for application and administration of the R&D Start grant



Data source: Responses to the R&D Start Program Questionnaire.

Collaborations

All of the respondents had collaborated exclusively with universities. Sixty per cent indicated that they had a prior relationship with the university, and 40 per cent had known the graduate prior to applying for the program. Most (70 per cent) of the applications were initiated by the firm with 20 per cent initiated by the university.

R&D expenditure and stages

The profile of the total expenditure on R&D was slightly lower than the grant recipients with a mean of $0.5 million (standard deviation of $0.7 million) compared to $1.6 million average for grant recipients. Expenditure on the project involving the graduate was a large proportion of total R&D spending for most firms, with an average of $0.38 million. Commensurate with the lower R&D expenditure levels was lower expenditure on plant and equipment, with an average of $0.07 million (standard deviation of $0.2 million).

The expenditure pattern differed from the grant respondents in that it was skewed more toward the development and proof of concept stage of R&D. Fifty three per cent of the funds allocated were in this category, with an average expenditure of $0.23 million (standard deviation $0.26 million). Three firms of the ten had invested in commercialisation and market establishment.

Impact on profitability

The profile of the impact on profitability was slightly higher than the grant recipient sample as 50 per cent of firms felt that they had more than broke even, compared with 20 per cent. In ten years time 80 per cent of firms indicated that they would more than break even, although none indicated that the return would exceed 10 times the cost. This pattern may be partly due to the smaller size of the R&D investment.

Economic outcomes, flow-ons and spillovers

The products of the R&D varied slightly from the grant recipients in that a higher share developed a better product/service (40 per cent compared to 20 per cent). A higher share also reduced costs of production (30 per cent compared to 7 per cent). A lower share developed a new product/service (20 per cent compared to almost 30 per cent).

The responses to the value of the product to the customers is similar to the grant responses except that no firms indicated that their customers were prepared to pay a price premium.

Spillover effects

Only 30 per cent of the firms had protected their IP, and only one (10 per cent) with patents. The responses on maintaining competitive edge were similar to the grant recipients.

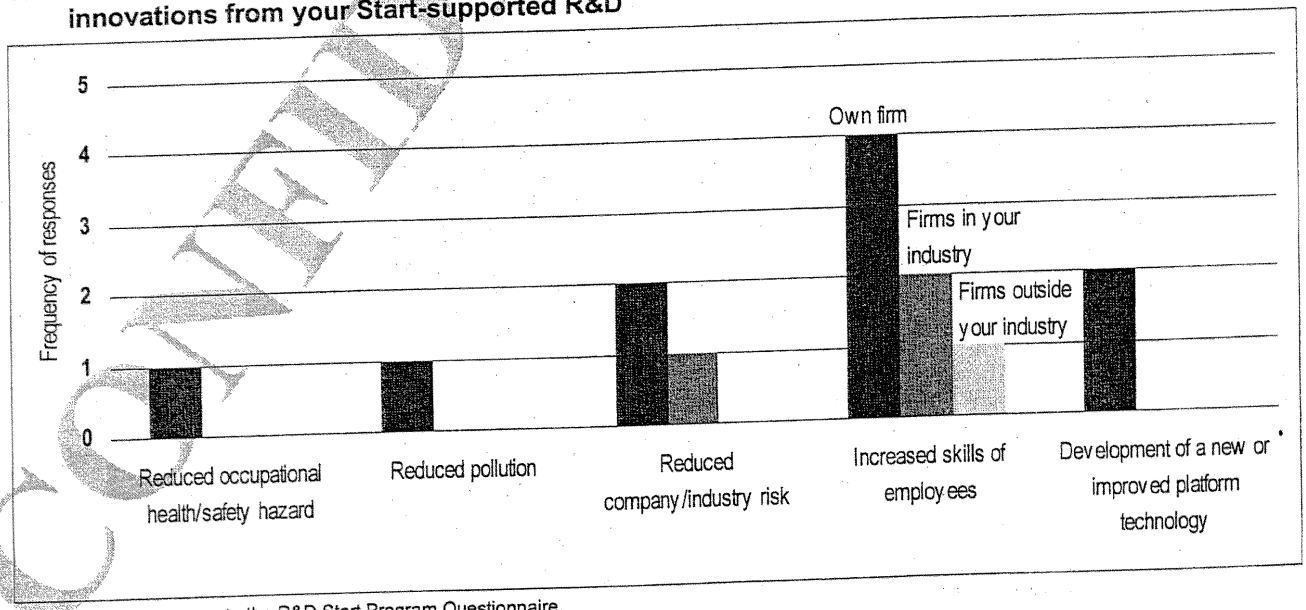
There were a variety of other spillovers identified in the survey responses. These are summarised in chart 3.28. The responses imply that the benefits are largely captured by the firms themselves, with the main exception being the skill development impact.

Collaborations

There is evidence of a higher impact on opportunities for collaborations and joint ventures with 30 per cent of respondents indicating a strong impact in this area (compared with 20 per cent of grant recipients). In 40 per cent of firms this is in the area of further R&D collaborations, while 10 per cent indicated further business ventures.

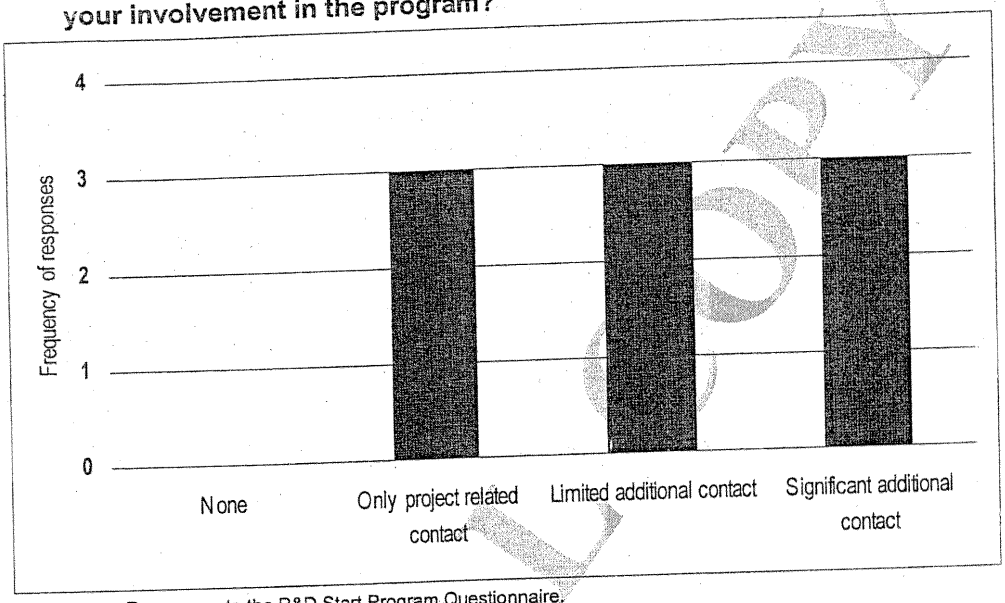
The program did provide some access to expertise in the university beyond the graduate involvement. Chart 3.29 summarises the responses.

3.28 **Please indicate if there have been any other significant flow-on economic impacts or innovations from your Start-supported R&D**



Data source: Responses to the R&D Start Program Questionnaire.

3.29 **What access to expertise in the research institution was facilitated by your involvement in the program?**



Data source: Responses to the R&D Start Program Questionnaire.

The program has generally resulted in the employment of the graduate following the completion of the program. Seventy per cent are still employed with the firm and several firms commented that they thought the program was an excellent way of identifying and training good people. In only one case was the graduate not employed and this person had returned to further study. This was also the case where the respondent indicated that the main motivation and benefit came from access to the university laboratory facilities. However, the importance of identifying good people is only one factor identified in the response to a question on the sources of impact from collaboration. Chart 3.30 summarises the responses.

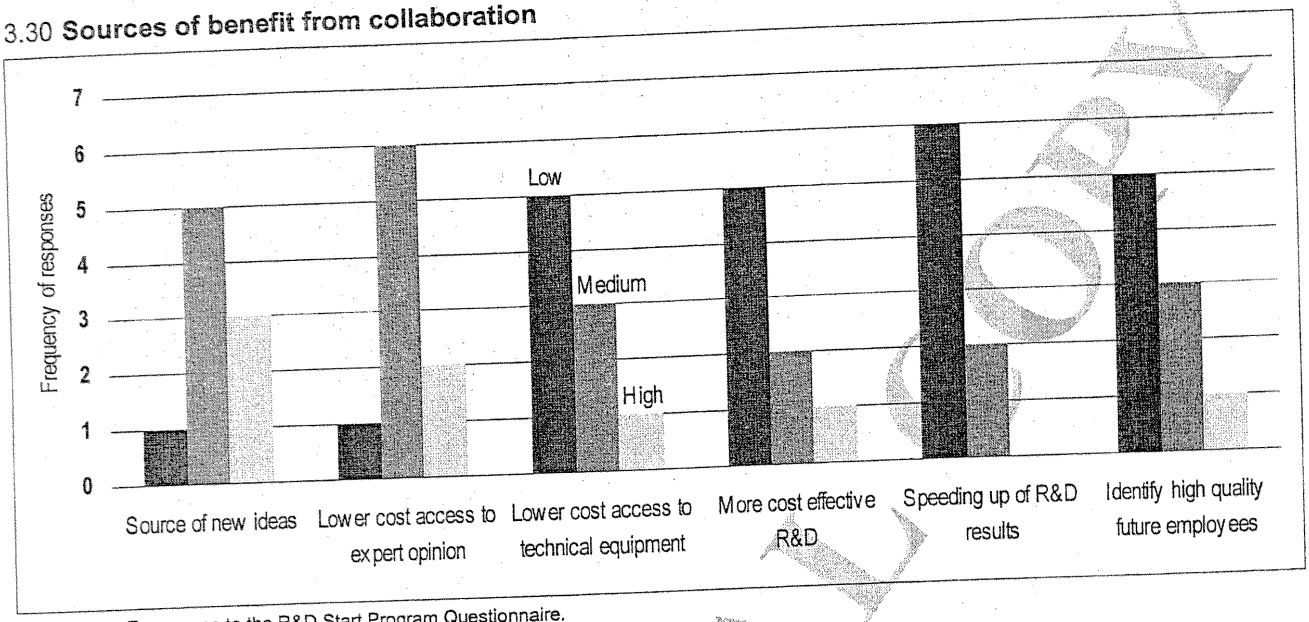
Start Loan

The response rate for the Start loan survey was 39 per cent, but as there are only a relatively small number of loans, there are only 12 responses. As with the Start Graduate, the small sample size makes it difficult to draw conclusions about the Start Loan population.

Profile of the respondents

All of the firms responding were private companies. The average number of employees (14) was lower than the grant respondents reflecting the absence of any very large companies in the Start Loan population. All respondents had less than 30 employees. The turnover pattern was

3.30 **Sources of benefit from collaboration**



Data source: Responses to the R&D Start Program Questionnaire.

commensurately lower with an average turnover of $1.5 million and all firms in the zero to $3 million turnover category.

Involvement with other R&D programs

Fifty-eight per cent of the firms had previously been involved in an R&D program, predominantly a loan program of some kind. Only one firm (8 per cent) had received a Start grant prior to successful application for the loan. This compares with 42 per cent of grant respondents receiving some form of government assistance for R&D, of which only 20 per cent had received a Start grant before.

Collaborations

Most of the R&D was conducted by the firms, with only two reporting collaborations. One was with a private company and one with a university. While a small sample, this is very similar to the profile of the Start grant recipients.

R&D expenditure and stages

The profile of the total expenditure on R&D was lower than the grant recipients, with a mean of $0.36 million (standard deviation of $0.3 million) compared to an average of $1.6 million for the grant recipients. Expenditure on the project for which the loan was provided was a large proportion of this for most firms, with an average of $0.21 million. Commensurate

with the lower R&D expenditure levels was lower expenditure on plant and equipment, with an average of $0.15 million (standard deviation of $0.3 million). This was higher as a share of expenditure (on average, the share was 38 per cent) than for the grant recipients (on average, 22 per cent).

The expenditure pattern differed from the grant respondents in that it was skewed more toward the commercialisation stage of the innovation cycle, as would be expected. Fifty seven per cent of the funds allocated were in this category, with an average expenditure of $1.39 million (standard deviation $2.7 million). All firms except for one, where the product failed, had invested in commercialisation and market establishment.

Impact on profitability

The profile of the impact on profitability was similar to the grant recipient sample, with 25 per cent of firms indicating they had already more than broken even compared with 20 per cent. In ten years time, 66 per cent of firms indicated that the project would more than break even and 75 per cent would at least break even. This is substantially lower than the grant recipients (85 per cent), when the opposite would have been expected as the loans are targeted at projects that are closer to commercialisation. While this may be the result of the small sample, it could also indicate the size of the optimism bias. It appears that the further firms are away from commercialising and marketing the products produced by R&D, the higher their assessment of the benefits.

Economic outcomes, flow-ons and spillovers

The shares of products of the R&D were very similar to the grant recipients in that the highest share was better products or services (58 per cent) followed by increased intellectual property (also 58 per cent). Fifty per cent reported a better product or service while only 25 per cent reduced their own costs of production. Forty-two per cent reported increased opportunities for new ventures or collaborations.

All of the firms were focused on the domestic market in the short run except for one firm, which is currently getting 73 per cent of sales from exports. In ten years time two other firms expected to export, but only very small volumes. The responses to the value of the product to the customers suggest much greater value to customers than to grant recipients. Thirty-three per cent of firms said customers were willing to pay a price premium compared to 12 per cent of grant recipients. Fifty-eight per cent of firms felt that the product had reduced costs for the business customer, and 58 per

cent felt it had improved their customer's product quality. The indicative cost saving for customers for the seven firms who responded to this question totalled $13.8 million. This is much higher than the 21 and 24 per cent of grant recipients who had reduced costs or raised quality for their customers respectively. Forty-two per cent of loan recipients reported that customers had switched to their product.

Spillover effects

All of the firms (except the technical failure) had protected their IP, all but one in at least two ways. Fifty per cent had taken out patents and 25 per cent other IP rights. The responses on maintaining competitive edge were similar to the grant recipients.

There were a variety of other spillovers identified in the survey responses. These are summarised in chart 3.31. The responses imply greater spillovers on average than for the grant recipients. As a percentage of respondents, the spillovers to other firms in the industry and to other industries is well over twice that of the grant recipients despite the higher level of IP protection. The small sample, however, makes drawing any conclusions problematic.

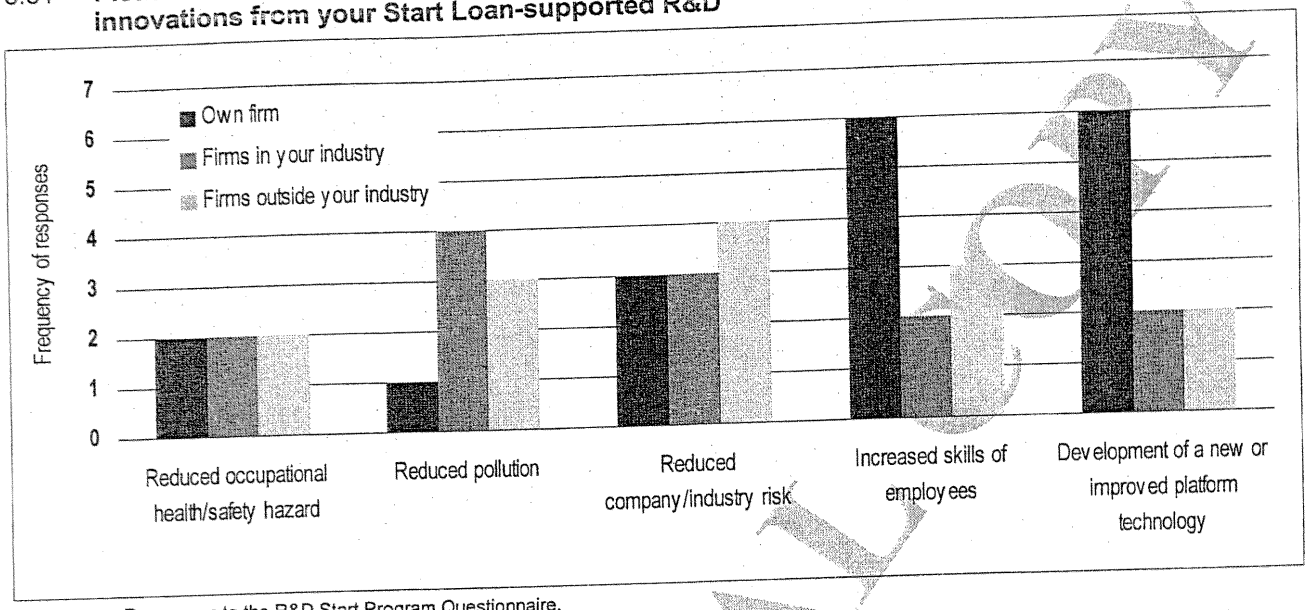
Collaborations

There is evidence of a higher impact on opportunities for collaborations and joint ventures with 58 per cent of respondents indicating a strong impact in this area (compared with 20 per cent of grant recipients). In 25 per cent of firms this is in the area of further R&D collaborations, while 25 per cent also indicated collaboration in market development.

Repayment performance

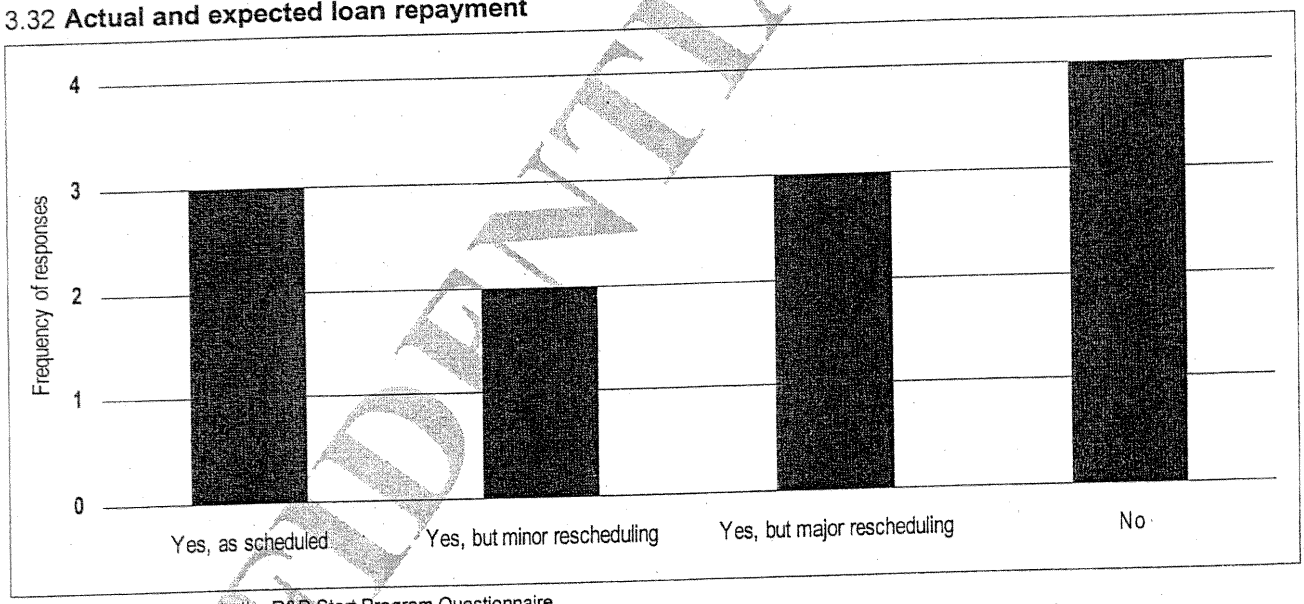
Despite there being only one acknowledged failure of the technology, forty-two per cent of the firms are yet to start repaying their loans, and a third indicated that they did not anticipate being able to make repayments. Chart 3.32 summarises the response to the question on having made, or anticipate being able to make. repayments. The reasons given relate mainly to the need for more time to make repayments due to factors such as market downturns (IT), the market moving in new directions, making the new technology redundant and cash flow problems for other reasons.

3.31 Please indicate if there have been any other significant flow-on economic impacts or innovations from your Start Loan-supported R&D



Data source: Responses to the R&D Start Program Questionnaire.

3.32 Actual and expected loan repayment



Data source: Responses to the R&D Start Program Questionnaire.

4 Benefits and costs of R&D supported by Start

Survey results for grant recipients suggest that, in aggregate, they expect their R&D to eventually be highly profitable (charts 3.8 and 3.9). Here we use the quantitative benefit-cost framework discussed in appendix B to assess the private as well as broader flow-on costs and benefits of R&D.

Full costs of R&D

To assess the broader costs of R&D we must include several categories of costs (table 4.1).

Total R&D cost consists of:

- direct investment in R&D projects, which is composed of funding from the Start program and the firm's private funds, as well as previous expenditure by the company in the R&D project;
- the administration and compliance cost in the life of the project; and
- the tax burden of raising public funds (Start program funds).

The cost burden of raising tax comes from the distortions imposed on the rest of the economy from raising taxes. Taxes create disincentives to work and invest, and cause resources in the economy to be reallocated away from their optimal. Various empirical studies estimate the cost burden of

4.1 **R&D costs on a present value basis discounted at 5 per cent**
Present value ($m)

	Start program	*Private funds*		*Administration*	*Tax burden*	*Total*
		Project cost	*Previous R&D*			
Recipients						
▪ Grant	138.70	337.02	69.00	11.71	46.13	602.56
▪ Graduate	1.76	2.24		0.27	0.88	5.16
▪ Loans	3.90	20.54		0.30	1.95	26.70

Source: CIE and survey data.

taxes at between 15 and 40 cents in every dollar of tax raised. Here we use the mid-point of 28.

Compliance costs from the survey results (chart 3.27) are around 8 per cent of the value of the R&D Start grant. However, as there is some ambiguity about whether these are already included in project costs, they are assumed to be zero here. Administration costs are estimated at around 6 per cent of the R&D Start grant and cover the staffing and overhead costs of the IR&D Board, AusIndustry and the policy division of DITR involved in administering the scheme.

Estimates of the private and Start investments in R&D come directly from the survey. Another cost of the R&D is the opportunity cost of the capital used in each project. This accumulates through time and accumulates the longer the funds are not available for alternative uses. To account for it in the benefit–cost evaluation we initially use a discount factor of 5 per cent. This is accounted for by presenting the costs in table 4.1 in present value terms.

Perceived private benefits of R&D

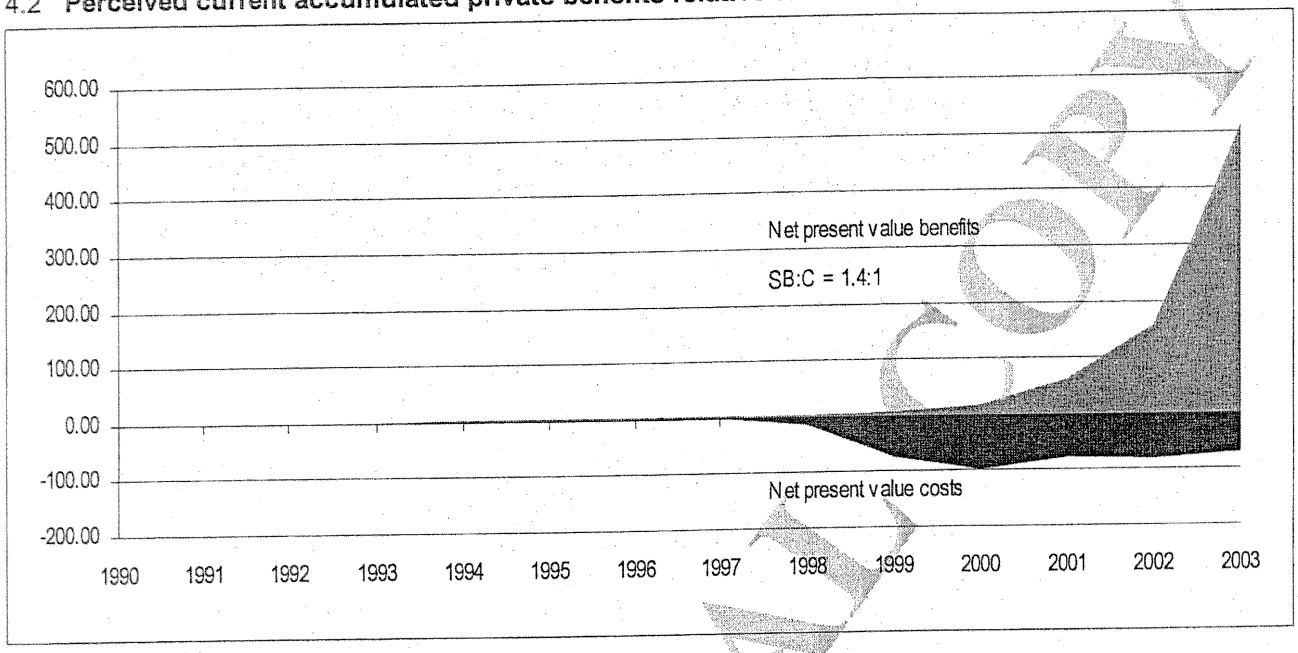
Chart 4.2 summarises recipients' responses about their perceptions of their accumulated financial returns from their R&D Start supported projects so far, relative to the direct financial costs of the project. The weighted average response suggests that, as a group, the private benefits received have exceeded total costs (own, R&D Start, administration, and burden of tax) by about 40 per cent. The average benefit to cost ratio is 1.4:1.

The distribution of benefits, however, is highly skewed. As discussed in chapter 3, 72 per cent of respondents indicated that they had not reached a breakeven position. In fact, on average, this group was less than half way to breaking even. However, the weighted average result is considerably better on account of a few large firms having done very well. This may partly reflect the riskiness of R&D.

Perceived benefits are very high

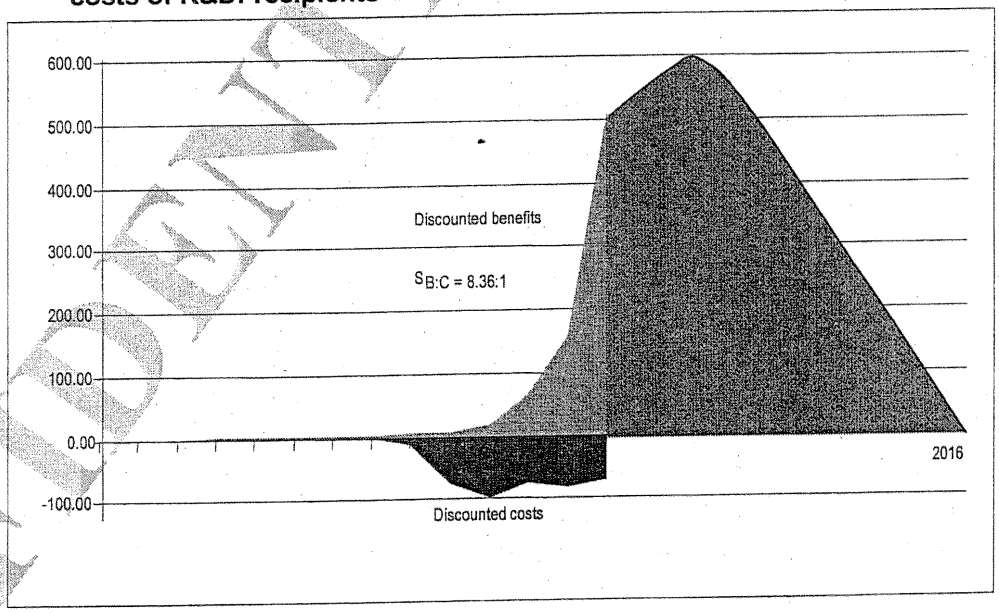
Chart 4.3 extends the expected flow of benefits for another 13 years. It shows benefits peaking in five years and then declining to zero by 2017. The decline is due to financial discounting as well as product obsolescence.

4.2 **Perceived current accumulated private benefits relative to estimated social costs of R&D**



Data source: CIE model.

4.3 **Perceived current and future private benefits relative to estimated social costs of R&D: recipients**



Data source: CIE model.

We cannot be certain of the pattern of accumulating and declining future benefits, but the pattern indicated fits the data best on average. In reality, some new technology may continue to have a positive effect well in to the future, while other technology may have a very short product life cycle.

On average, respondents' expectations are for private benefits to exceed total costs by 7.33 times. However, over the approximate 20 year life of the

projects, this converts to an overall internal rate of return of 40.5 per cent — table 4.4. The external rate of return (CIE 2002) is 15.2 per cent — were the funds invested in R&D alternatively invested at a compound rate of 15.2 per cent above the discount rate of 5 per cent for the average 15 year pay-back period, the same benefit to cost ratio could be achieved. This is a high sustained rate of return.

Even discounting for various biases, high private returns are expected

The high expected rate of return might reflect a typical R&D optimism bias. It may also reflect some survey bias and the relatively low financial discount rate of 5 per cent.

Typically, managers of R&D projects are overly optimistic about their probabilities of technical, commercialisation and market development successes. This may reflect the fact that many unforseen difficulties face new products and technologies in their development. Almost by definition, any expectation of future benefits is difficult to account for except in a very general way based on past experience. A random sample of 30 AusIndustry final project reports shows that over the expected average 18 month life of an R&D Start grant, on average, projects took 30 per cent longer to achieve their benchmarks than expected. Experience in evaluating many R&D projects suggests that optimism biases of around 50 per cent are common in considering most benefits of the project. Using the 30 per cent time optimism bias as an indicator of project optimism bias for R&D Start projects may be conservative.

The survey bias refers to the low level of responses from recipients who were technically unsuccessful. AusIndustry data suggests 15 per cent of recipients were technically unsuccessful. However, only between 1 and 4 per cent of respondents were in this group. To properly assess the benefits of the program, we need to factor this into recipients' costs and assume no benefit due to technical failure. Effectively, this would lower the benefit to cost ratio by 10 per cent.

4.4 Estimated private benefits and costs: recipients

Results	*PV $ benefit*	*PV $ cost*	*B:C ratio*	*IRR*[a]	*ERR*[a]
	$b	$b		%	%
Based on survey data	5.02	0.60	8.36	41.9	15.2
Optimism bias discount	3.51	0.60	5.85	33.6	12.5
Survey bias discount	3.51	0.66	5.32	31.3	11.8
Doubling of discount rate (5–10%)	3.12	0.66	4.73	31.3	10.9

[a] IRR and ERR take account of the time required to achieve a certain present value B:C.

Source: CIE and survey data.

Discounting the results presented in chart 4.3 for these two possible biases produces the results presented in table 4.4. Discounting for a possible 30 per cent optimism bias lowers the benefit to cost ratio accordingly. Discounting it another 10 per cent for the under-representation of technical failures lowers it still further. The internal rate of return falls to around 30 per cent and the external rate of return falls to 11.8 per cent. At a higher discount rate of 10 per cent, the benefit to cost ratio declines to 4.66:1 and an external rate of return of 10.8 per cent. This sort of rate of return is within the bounds of good expected commercial returns.

The results presented in table 4.4 suggest that, even after correcting for various uncertainties about research outcomes, realistic expectations are for high private rates of returns from their R&D investments.

Estimated economywide benefits and costs of R&D projects

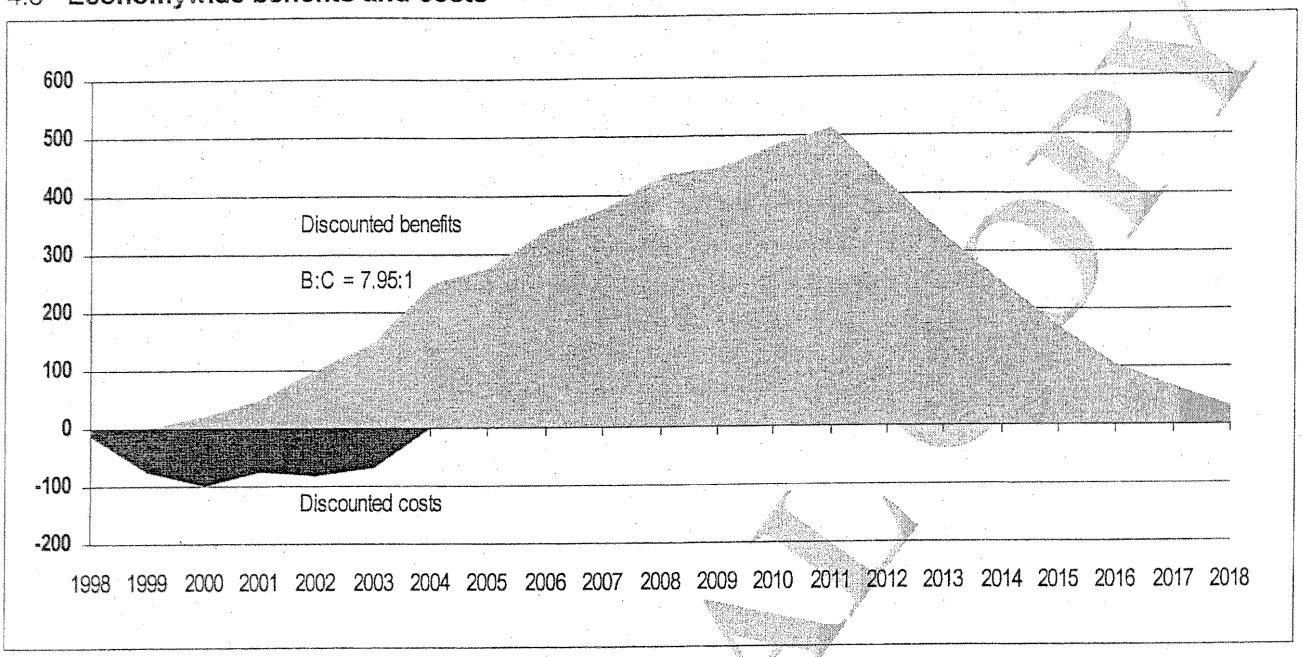
R&D diffuses through the economy creating flow-on effects, and in some cases passes original benefits generated by initiating firms to their customers and competitors. But diffusion may also impose costs. To the extent that R&D is successful, it may reduce the business of competitors or bid up the cost of highly skilled labour, bidding it away from other industries.

Here we use data from part 4 of the survey to assess how R&D outcomes will impact on the domestic, export and import supply and demand of Australian industries affected by Start supported R&D. This is done using the CIE ORANI model of the Australian economy. The results represent a detailed adding up of the economywide, market-mediated benefits of Start R&D.

Estimates of market-mediated economywide benefits are also high

The economywide estimates of benefits and costs are summarised in chart 4.5. That the full economywide benefits are similar to the perceived private benefits also suggests that recipients' own perceptions of their private benefits are optimistic, because the benefits shown in chart 4.5 include both private and flow-on benefits combined. However, irrespective of how the gains from the R&D are distributed in the economy, the results represent a detailed analytical verification (see box 4.6) that the R&D supported by Start is expected to have a healthy payoff for the economy. Present value economic benefits of $4.8 billion are expected over the next 15 years for total outlays to date of around $0.6 billion.

4.5 Economywide benefits and costs



Data source: CIE model.

4.6 The analytical approach versus perceptions

The analytical verification is detailed because it is the aggregation of the market and industry analysis of up to five different possible R&D outcomes (productivity increases for own firm, productivity increases for competitors, productivity increases for business customers, export demand increases, household demand increases) by 118 R&D projects. Moreover, up to 20 different answers to quantitative survey questions may have been referenced to make a quantitative assessment of each R&D outcome. It is therefore a detailed bottom-up integration of about 10 000 separate quantitative answers from respondents used to form a logic picture of the potential impacts of their R&D.

By comparison, the estimates of perceived private benefits are impressionistic and based on about 200 answers. Nonetheless, they are valuable because they are made by those closely involved in the work and, taken together, the two different estimates point toward high expected average returns.

4.7 Estimated economywide benefits and costs: recipients

Results	*PV $ benefit*	*PV $ cost*	*B:C ratio*	*IRR*	*ERR*
	$b	$b		%	%
Based on survey data	4.79	0.60	7.95	40.5	14.8
Optimism bias discount	3.35	0.60	5.56	32.3	12.1
Survey bias discount	3.35	0.66	5.06	30.1	11.4
Doubling of discount rate (5–10%)	2.99	0.66	4.50	30.1	10.5

Source: CIE and survey data.

Discounting for various biases still leaves high market-mediated returns. Applying the same corrections we applied in table 4.4 to the economywide

results defines table 4.7. The more conservative view of the benefit to cost result is a ratio of around 4.5:1.

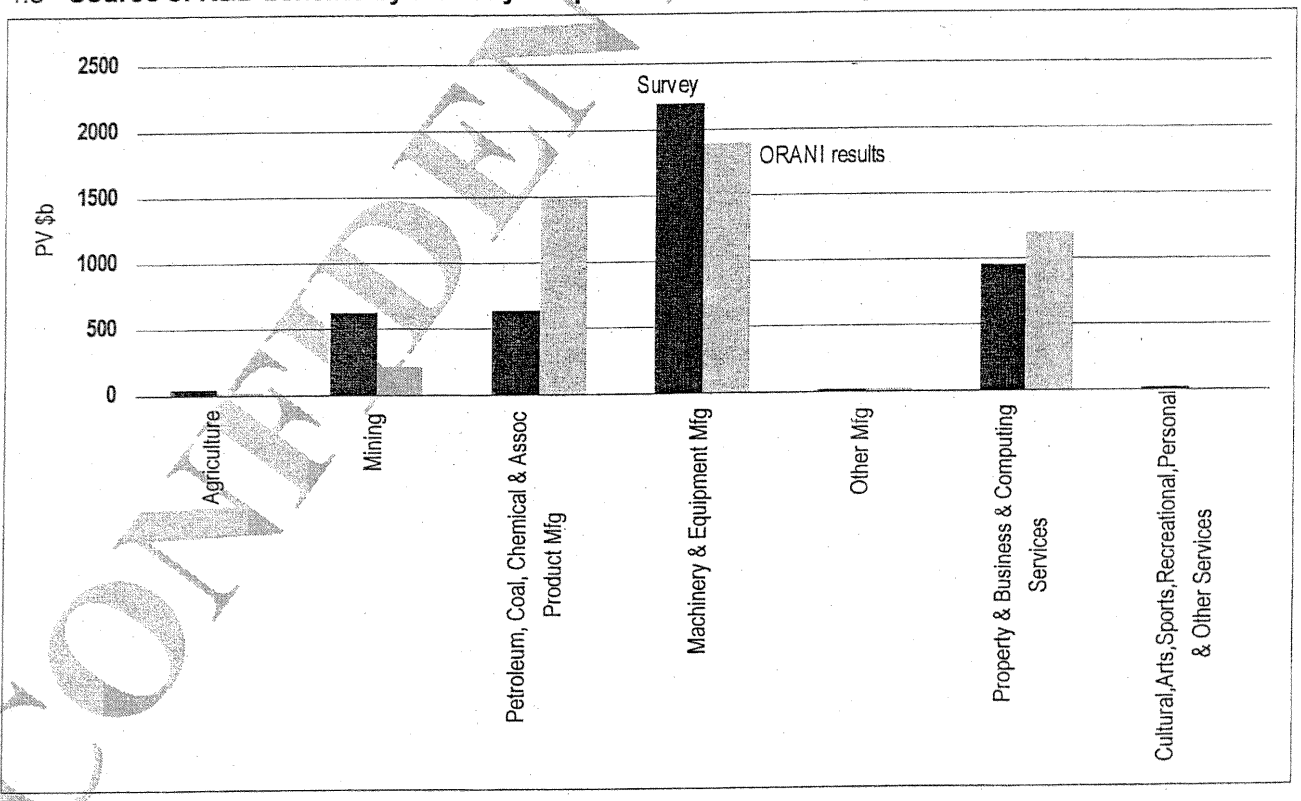
Distribution of benefits through the economy

Chart 4.8 shows the economywide and perceived private benefits generated by each industry conducting R&D. For five of the main industries conducting R&D, the perceived and economywide benefits are similar, with three industries:

- machinery and equipment manufacturing
- petroleum, coal, chemical and associated product manufacturing
- property, business and computing services

by far the largest contributors. The difference between the perceived and economywide benefits in mining and agriculture may be due to the fact that, because of the high export intensity of both industries, most of the benefits will end up in the hands of foreign consumers. The economywide estimates are better able to pick up such effects because second and subsequent round economic impacts are systematically accounted for. By

4.8 **Source of R&D benefits by industry: respondents' direct survey results and ORANI results**



Data source: CIE model.

comparison, respondents may not factor in such market interactions in their perceptions of benefits. For the petroleum, coal, chemical and associated product manufacturing industry the opposite may be at work. Import replacement effects may end up lowering prices to consumers.

The main beneficiaries of the economywide benefits are the three main industries initiating the R&D. Machinery and equipment manufacturing, and property, business and computing services tend to benefit relatively more than the petroleum, coal, chemical and associated product manufacturing industry. The latter passes more of its gains forward to other industries or consumers. Initiating industries receive their benefits either directly due to the initiating firm, or indirectly as the innovation diffuses to competitors. The main using industries benefiting from the R&D are: utilities, motor vehicles and transport and storage, communication services, finance and insurance, and high tech industries. Other industries incur small costs due to the impact the R&D imposes on wage rates (which rise) and the exchange rate (which rises due to increased export sales). Net annual export sales increase by around $250 million a year and imports increase by $100 million a year.

Overall, in addition to the initial, first round benefits from R&D, the net increased economic benefit induced by second and subsequent round flow-ons from the R&D is around 20 per cent. That is, for each dollar of initial benefit, an additional 20 cents is generated.

Knowledge spillovers

The extent of knowledge spillover from R&D will depend on:

- how appropriable the benefits from R&D are – the easier it is to protect intellectual property, through patents and other means, the lesser the opportunity for spillovers;
- the extent to which technical and commercial skills developed by the company doing the R&D may be transferred to other companies when staff leave;
- the novelty and applicability of the technology to others, the more novel and applicable it is, the more likely it may spur the development of other new applications and products;
- how rapidly the influence of the new technology diffuses through the domestic economy rather than leaking to the international economy – the faster it diffuses domestically, the more likely it is that spillovers will be large;

- the extent to which it promotes collaboration — more collaboration increases the chances of new applications and spillovers.

On these factors, recipients' responses indicate the following.

- Fifty-seven per cent of respondents indicate strongly protecting their R&D.
- Ten to 20 per cent of firms indicate that increased skills of their workers may provide spillover benefits to other firms in their industry (20 per cent) and firms outside their industry (10 per cent);
- Ten to 20 per cent indicate novel or platform technologies that might be of benefit to firms other than their own — most R&D is highly applied rather than basic or focused on developing platform technologies.
- Around 90 per cent of respondents do not expect to quickly lose their competitive edge to rivals (in under five years) and about 75 per cent of increased sales resulting from the R&D are expected to be exports.
- Twenty-four per cent of recipients involve collaborators in their R&D.

Other spillovers

Sixteen per cent of respondents indicated creating spillovers relating to occupational health and safety or pollution. Mostly, these gains related to their own firms, suggesting gains are likely to be minimal given their small size on average. The estimate is of a gain with a net present value of around $1.2 million. Were this duplicated for all firms indicating additional spillovers, total gains would only amount to around $20 million. Even doubling these as an estimate provides only small benefits.

5 Additionality: the evidence

The evidence compiled so far provides considerable information about the sort of relationship between the market-mediated benefits and total costs, such as depicted in chart 2.1, for R&D Start supported projects. From such information, we can assess the evidence on additionality and hence the net national gain in R&D benefits Australia derives from its spending on R&D. It is worth noting that there is no evidence to support the notion that Start supported R&D has greater benefits (to the firm, in flow-on effect or via spillovers) than any other R&D. Consequently, the value of the Start program is derived solely through its additionality.

Net national gains from R&D Start funding: additionality

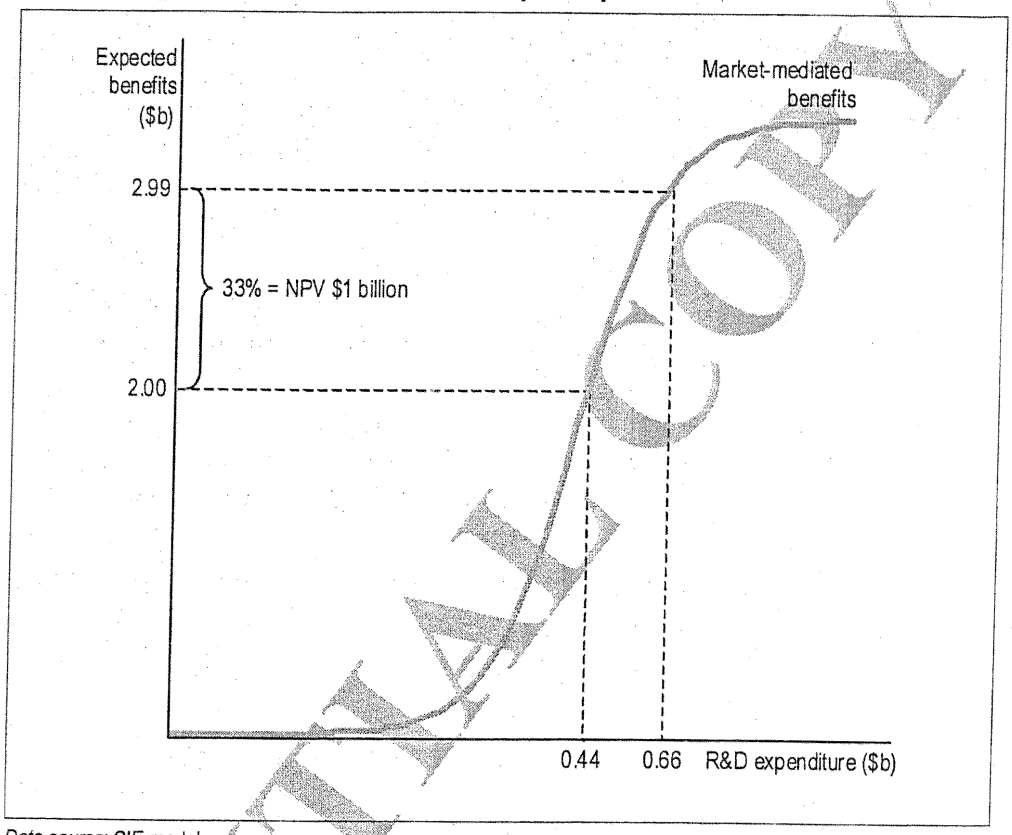
Evidence presented by respondents in part 5 of the questionnaire (see chapter 3) suggests that the market-mediated benefit to total cost relationship for recipients is as depicted in chart 5.1. Several elements of recipients' responses suggest that, with their own and Start funding they are positioned high up on their marginal benefit to cost curves to achieve the average benefit to total cost ratio of 4.5 to 1. Spending more money on R&D would start to show fairly severely diminishing returns.

- Around two thirds of recipients said that with Start their total funding was adequate to conduct their R&D efficiently.
- On average, a doubling of Start funds would only increase the expected benefits by between 5 and 15 per cent in terms of reduced time to commercialisation and probability of success.

However, although approaching severely diminishing returns, responses suggest that the additional Start funding received by recipients allowed them to climb a steep part of the curve and achieve high marginal return. Without Start funding:

- about two thirds suggest that their probability of success and the scope of their R&D would have halved — a possible 33 per cent reduction in benefits from $2.99 billion to $2 billion in chart 5.1; and

5.1 **Average benefit to cost relationship: recipients**



Data source: CIE model.

- only about a third indicated that they would probably have proceeded with their R&D anyway, creating no real change.

Big national gains from R&D Start funding perceived

On the evidence above, it could be argued that the provision of Start funds is expected to add 50 per cent to the total benefit expected to be received from R&D Start supported R&D. This equates to a present value gross national benefit of around $1 billion (0.33 times benefit in table 4.7).

The present value private benefit of around $1.0 billion to the extra (present value) social cost (government's 33 per cent share of total costs in table 4.1) of $0.22 billion, suggests a benefit to cost ratio of around 4.5:1 before taking account of spillovers. This appears to be a healthy rate of return on Start funds – external rate of return = 10.5. This is consistent with the House of Representatives Standing Committee on Science and Innovation (2003), which has been told about the program's 'great success'.

But there are inconsistencies that must be explained

The benefits are, however, market-mediated benefits. This creates an inconsistency in the evidence presented by recipients. Given the very high rate of return from market-mediated benefits — which should be able to be captured by the market — it is not clear why firms were not able to secure funds to undertake such an expansion of R&D.

Are there severe capital market failures?

To believe the evidence presented by recipients requires the assumption that there is a large capital market failure. The proposition must be that the capital market, despite its position to efficiently spread risks, is not attracted to funding R&D investments with such high rates of return as those conducted under the Start program.

What the data says with no assumption of capital market failure

If there is no capital market failure, additionality from the program will depend solely on the spillovers created by the additional R&D induced.

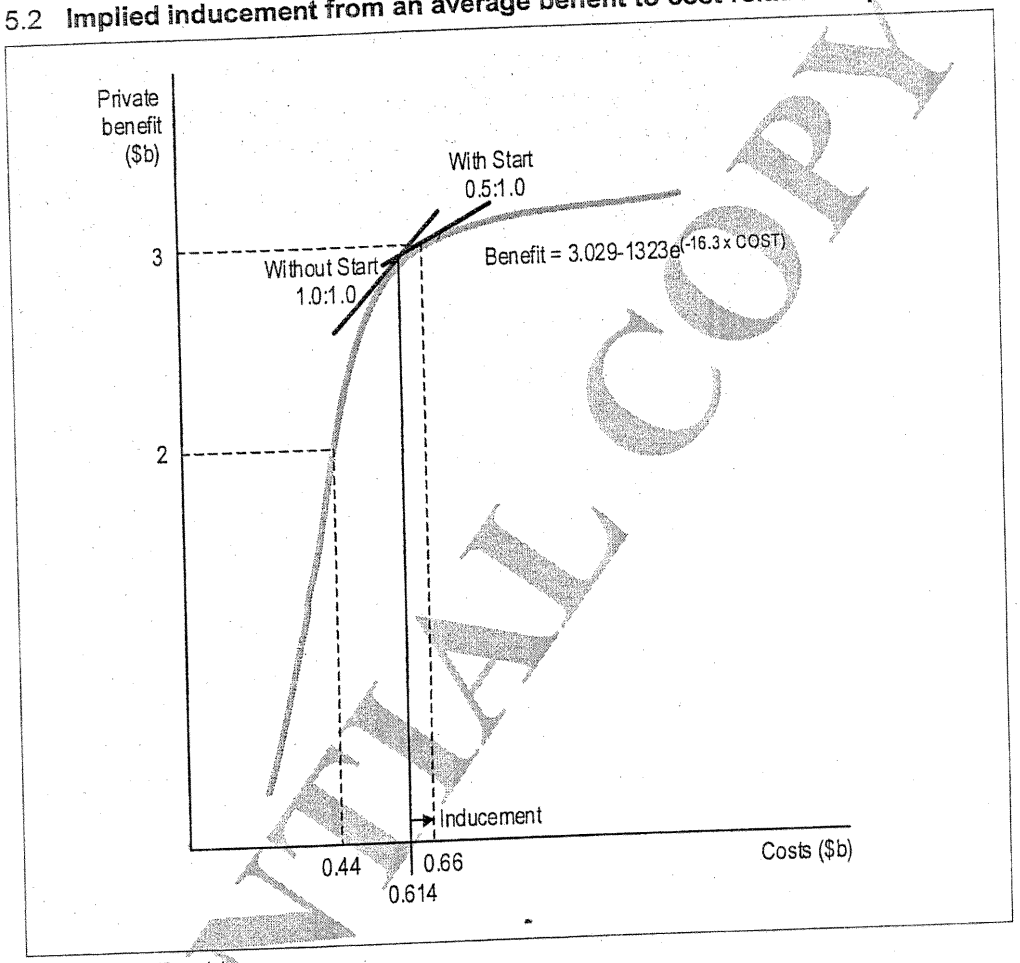
Indicators of inducement

Estimates of the percentage of each dollar of R&D subsidy that ends up inducing more R&D vary widely. Of each dollar of R&D subsidy, some may crowd out funding that would have occurred anyway. Further, because of diminishing returns to each additional dollar of R&D invested in a project, it is unlikely that, in a matching dollar grant scheme, all of each extra dollar will be spent on extra R&D.

If there is no capital market failure, firms could be expected to behave as depicted in chapter 2 and we can interpret survey data accordingly. In the absence of Start funds, firms should expand their R&D spending up to its economically optimal point: where their marginal benefit equals its marginal cost — that is, 1:1. However, with matching Start funds, they will proceed beyond this point, up to the point where their marginal private benefit from the R&D equal 0.5:1. This is the purpose of the R&D grant. A relationship between benefits and costs that fits the survey data and these two marginal conditions is that depicted in chart 5.2.

Our financial model depicted in chart 5.2 suggests that, in the absence of Start funds, in the absence of a capital market failure and given the functional form depicted, recipients would face financial incentives to invest $0.614 billion on R&D. With the Start funding of $0.22 billion, survey

5.2 **Implied inducement from an average benefit to cost relationship**

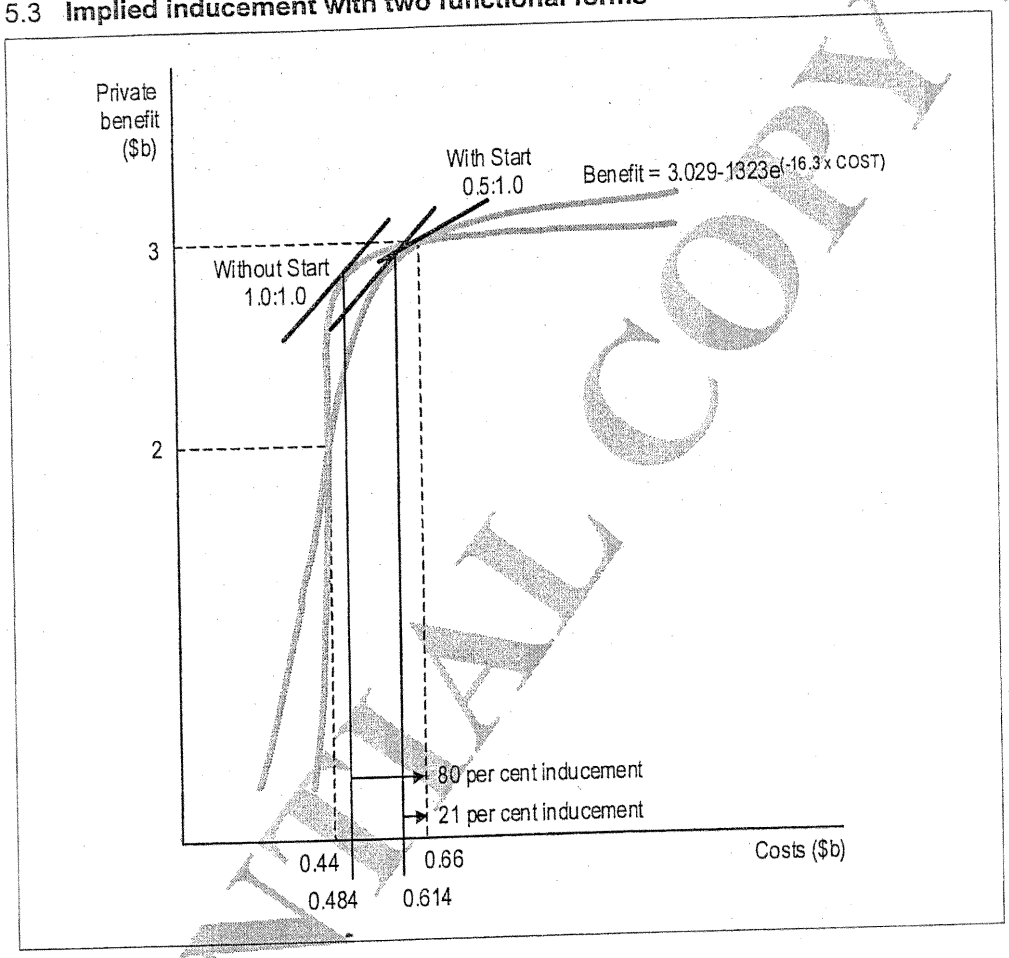


Data source: CIE model.

data suggests they spent $0.046 billion more on R&D at $0.66 billion. Based on the functional form chosen, this would suggest that Start caused a 21 per cent inducement rate. That is, of each extra dollar provided through Start, 21 cents was spent on R&D and the remainder was absorbed as a transfer subsidy. For example, rather than recipients foregoing wages to finance the project, recipients could afford to pay themselves. The R&D Start funds induced a climb up the steep part of the curve, but as this started to place firms hard up against increasingly diminishing returns, their capacity to further absorb the funds and use them usefully diminished, encouraging them to substitute Start funds for their own.

Other functional forms could be fitted to the survey data. Those with an even steeper initial slope, but then a more rapid flattening at the top, would suggest a higher rate of inducement. With a very steep, then rapidly flattening curve it is possible to imagine an inducement rate perhaps as high as 80 per cent — chart 5.3.

5.3 **Implied inducement with two functional forms**



The impressionistic evidence presented by respondents perhaps suggests that the inducement rate lies between these two extremes. Without Start funds:

- only a third of recipients indicated they would probably have proceeded anyway, suggesting that two thirds would not and therefore a maximum inducement factor of 67 per cent of the start funds – 50 per cent implied they would probably not have proceeded and about 15 per cent did not answer; and
- on average, 89 per cent of recipients indicated that the project cost to them would have increased by 72 per cent, suggesting that, on average, they may have maintained total R&D spending at 66 per cent of the Start equivalent funds anyway and suggesting that the minimum inducement effect would be as low as 33 per cent.

Impressionistic evidence is that the inducement effect of Start funds may be between 33 and 67 per cent.

Although none of the pieces of evidence above by themselves provide a convincing estimate of the inducement rate from Start funds, it would appear it is less than 1:1, but greater than zero. We consider that taken together, the best unbiased estimate is that about $0.50 of extra R&D is induced for each dollar granted under Start.

Spillover estimates

Indicators of spillovers from the survey suggest the following.

- About 85 per cent of projects were successfully completed, suggesting that a range of new products and processes were generated and in the normal process of diffusion, it should be expected that this will spur on spillovers in the economy.
- Over half of respondents indicate strongly protecting their R&D, suggesting that they are likely to appropriate many of the gains from their R&D, thus reducing spillovers, but raising the private returns from R&D — private and market-mediated returns are indicated to be high.
- Between 10 to 20 per cent indicate novel or platform technologies that might be of benefit to firms other than their own:
  - high spillovers are expected to be associated with basic R&D or R&D focused on developing processes or platform technologies; and
  - possibly lower spillovers are expected to be associated with the applied or product oriented R&D mostly conducted through the Start program.
- Around 90 per cent of respondents do not expect to quickly lose their competitive edge to rivals (in under five years) and about 75 per cent of increased sales resulting from the R&D are expected to be exports, suggesting that the influence of new technologies will not diffuse rapidly through the Australian economy.
- Less than a quarter of recipients involved collaborators in their R&D, and the higher the level of collaboration the higher spillovers are expected to be.

Although estimates of the present value knowledge spillovers are wide ranging.

- Most Australian reviews of R&D subsidy programs have placed them between \$0.25 and \$0.90 for each dollar of R&D — however, it is possible to derive estimates as high as \$5.52 (table 5.4).
- It is difficult to interpret most foreign studies on the question of spillovers. However, the differences between total returns and private returns (one indicator of this) could be as high as \$1.06 and a similar derivation for Australia is as high as \$1.22 (table 5.4).
- Most studies do not indicate how levels of spillovers vary by indicators of knowledge spillovers. However, 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, suggesting the possibility of high spillovers in these areas (table 5.4).

Implications for Start benefit to cost ratios

The implications of the varying spillover and inducement rates are set out in table 5.5. With an inducement rate of around 50 per cent, present value spillover returns need to be in excess of \$0.66 to breakeven (table 5.6).

The uncertainty surrounding estimates of the economic payoffs from spillovers leaves some doubt about the economic payoff from Start based

5.4 Estimates of present value returns from R&D

	Study location	*Spillover only*	*Total return from R&D — private plus spillover*
		%	%
Productivity Commission 2003 (clinical R&D)	Australia	25	
Productivity Commission 2003 (pre-clinical R&D)	Australia	58	
Lattimore 1997	Australia	70	
BIE (1993)	Australia	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	Australia	122	
Griliches and Lichenberg 1984 (product R&D)	Foreign		235
Griliches and Mairese 1990 (USA)	Foreign		100–130
Griliches and Lichenberg 1984 (process R&D)	Foreign		136
Many studies, Industry Commission 1995, table QA3 (all R&D)	Foreign		246–300
Derived from Industry Commission 1995	Australia	382	361
Mansfield various (basic R&D)	Foreign		468
Derived from Industry Commission	Australia	552	

5.5 Benefit to cost ratios by spillover and inducement rates

Spillover rates: Present value $ benefits per $ of R&D

Inducement rates	*0.25*	*0.28*	*0.34*	*0.41*	*0.51*	*0.66*	*0.87*	*1.23*	*1.75*	*1.94*	*4.09*	*5.53*
	← Most previous Australian reviews →											
0.10	0.73	0.73	0.74	0.74	0.75	0.76	0.78	0.80	0.84	0.85	1.00	1.10
0.20	0.76	0.77	0.78	0.79	0.80	0.82	0.85	0.90	0.97	1.00	1.30	1.50
0.22	0.77	0.77	0.78	0.79	0.81	0.83	0.86	0.92	1.00	1.03	1.36	1.58
0.30	0.79	0.80	0.81	0.83	0.85	0.88	0.93	1.00	1.11	1.15	1.60	1.90
0.40	0.83	0.83	0.85	0.87	0.90	0.94	1.00	1.10	1.25	1.30	1.90	2.30
0.50	0.86	0.87	0.89	0.91	0.95	1.00	1.08	1.20	1.38	1.45	2.20	2.70
0.60	0.89	0.90	0.93	0.96	1.00	1.06	1.15	1.30	1.52	1.60	2.50	3.10
0.70	0.92	0.93	0.96	1.00	1.05	1.12	1.23	1.40	1.66	1.75	2.80	3.51
0.80	0.95	0.97	1.00	1.04	1.10	1.18	1.30	1.50	1.79	1.90	3.10	3.91
0.90	0.98	1.00	1.04	1.09	1.15	1.24	1.38	1.60	1.93	2.05	3.40	4.31
0.95	1.00	1.02	1.06	1.11	1.18	1.27	1.41	1.65	2.00	2.13	3.56	4.52

5.6 Additionality and inducement from Start

Additional cost			*Additional benefits*
	$m		$m
Inducement	77.0	Market-mediated (private plus flow on)	92.4
		Knowledge spillover	50.8
Implied subsidy	77.0	Direct transfer to company	77.0
Dead weight loss (tax burden, compliance administration)	66.0	No benefit	0.0
Total	**220.0**	**Total**	**220.2**
Benefit to cost			**1:1**

Source: CIE model.

on spillovers alone. The economic payoff may be higher than breakeven, especially if the higher estimates of most Australian studies are applicable to Start induced R&D. However, the applied and product focus of the R&D and the strong focus on exports may mitigate against this.

A benefit–cost ratio above 1:1 suggests that, given the discount rate of 10 per cent used here, it has paid the community to undertake the program because it has covered its costs, including the opportunity cost of funds (the discount rate).

Should alternative subsidies be considered?

An argument raised about interpreting the results in the tables above is whether they should be compared with the effects of the R&D tax concession. The argument is put that, if a company does not receive Start funds, it may be entitled to an alternative government subsidy in the form of the 125 per cent tax concession. Our results compare the difference between a Start subsidy and no subsidy at all. They therefore measure the total economic benefits and costs of the Start program to the economy, not the partial benefits and costs relative to an alternative R&D subsidy program.

To measure the partial benefits and costs would require assessing the change in net additional benefits and net additional costs between the two schemes. To calculate this accurately would be an involved exercise and beyond the terms of reference of this study.

Case studies point to similar findings

The lessons from the case studies are fairly consistent with the more general results presented so far. The main lessons to emerge are as follows.

- The main impact of the program is to bring forward the R&D and raise the probability of success.
- There is some evidence that novel R&D is stimulated by the program —this could translate into higher returns mostly for the firm.
- Firms are good at protecting intellectual property and patents are only one way of doing this. First mover advantage is important in most cases.
- Despite protecting intellectual property, the firms face highly competitive markets, even with novel products. Thus, profit margins are relatively low, even for IT products.
- Sales are maintained only with continued effort in terms of ongoing development and customer service.
- Flow-on effects come mainly through the productivity improvement for the firm's customers. IT products generate less upstream impacts than the manufactured products, but potentially more downstream impacts (for users of the products).
- The R&D in the case studies was very much at the product development (or applied) end of the scale. This is not surprising given the applied, commercial focus of the program, but it does suggest that a

loan scheme (with repayment on success) would be just as effective in delivering the R&D.

Additionality and national benefits: the verdict

Despite very high expected market-mediated returns, recipients have argued their R&D and its benefits would have been greatly reduced without Start funds. Their written responses also emphasise this point. The high market payoff suggested by the recipients' evidence implies they face a capital market failure, rather than a severe problem relating to appropriating benefits of potential knowledge spillovers.

It is possible that there are communication failures that limit start-up companies' access to funds. This is possible under a number of scenarios.

- In an attempt to protect their IP, start-up companies may be shy about revealing their technological secrets, making it difficult to attract capital.
- Start-up companies are typically small and technically oriented and therefore lack the financial skills and experience to sufficiently impress potential investors.

It is also possible that these problems may be more prevalent for recipient firms if the Start program selection criteria tends to favour such projects. Indeed, some of the merit criteria for selection point to this possibility, in particular the criteria relating to 'whether projects would proceed satisfactorily without the financial assistance'.

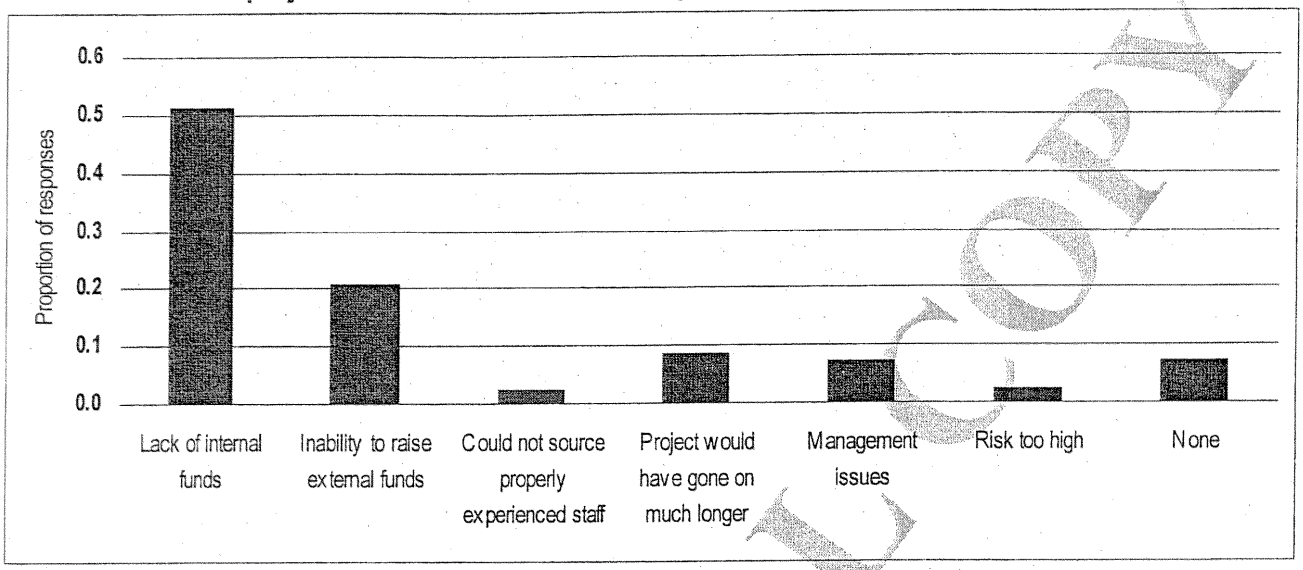
Written responses from recipients certainly indicate that the majority regarded the availability of funds as the major obstacle to completing the project when they commenced — 70 per cent (chart 5.7).

While it is not possible to provide a definitive answer on this point, if the Start program is solving these sorts of communication failures, it may provide an efficient use of public funds. In that case, the full national benefits to costs of around 4.5:1 estimated above may be a valid measure of the efficiency of the program.

Evidence of recipients is hypothetical

One explanation for the apparent difficulty of recipients acquiring funds is that the hypothetical survey question asked elicits an untested biased response. It is difficult for recipient firms to imagine how resourceful they could be in raising capital if necessary, when answering hypothetical

5.7 **Indications of project obstacles from written responses**



Data source: Responses to the R&D Start Program Questionnaire.

questions on the impact of not receiving Start funds. Given the high expected returns from their R&D, had they had to face such a challenge, they would have had a large economic incentive to vigorously pursue potential investors, find the funds and proceed with the project.

Capital market failure is a hard case to mount and spillovers look uncertain

Spillover benefits and the difficulties of appropriating such benefits of R&D are a major justification for subsidising R&D through the Start program. However, results presented here suggest that spillover benefits are uncertain.

If there is a capital market failure, the high expected market-mediated rate of return on R&D indicated in the results adds to the likelihood that R&D Start funds are an efficient use of public funds. However, the results suggest that firms are, on average, able to capture the majority of these market-mediated benefits. And if there are substantial flow-on effects not captured by a firm, it is likely that over time market structures would develop to stimulate this R&D (such as vertical integration and commissioning of R&D by the firms that benefit from the flow-ons).

6 Implications for objectives, selection criteria and instruments

Assessed against the objectives, the rationale and the selection criteria for the program, several implications emerge.

Achievement of stated objectives

Objectives

Increased number of projects with high commercial potential and fostering greater commercialisation

If there is a strong capital market failure affecting Start recipients, the number of R&D projects with high commercial potential have been increased.

Increased collaboration

About 25 per cent of recipients were involved with collaboration.

Additional national benefits

To make a strong case for Start based on spillover benefits, it will be necessary to demonstrate that spillover benefits are larger than most previous reviews of this type of program have assumed, as shown in table 5.5.

On capital market grounds, a stronger case may be made for national benefits than is the case with spillovers, provided that the source of the capital market failure can be identified.

The five selection criteria

Without being sure how firms without Start funds would have performed, it is difficult to assess the efficiency of the selection criteria: management capability; commercial potential of the projects; technical strengths of the projects; 'need for funding'; and national benefits.

The rationale

The primary rationale and economic justification for Start is based on knowledge spillovers. The secondary rationale may be to overcome capital market or information problems in the market place.

Spillovers

For any given estimate of spillover benefit, a constraint faced by Start seems to be the ratio of the spillover benefit to the estimated deadweight costs associated with raising taxes to fund R&D subsidies (which are commonly estimated to be $0.30 for every $1 raised).

- Because of diminishing returns to any project, only a proportion, perhaps 50 per cent, will be spent on additional R&D.
- For example, if the spillover rate is $1 for every dollar of induced R&D, and if the inducement rate is 50 per cent, then the benefit to cost ratio will be 1.2:1 — that is, 1+((1*0.5)-0.3=0.2):1. The higher the spillover rate, the more it is able to cover the deadweight cost.
- Further serious investigation into the robustness of macroeconomic estimates of spillover benefits and the link between microeconomic causes of the macroeconomic estimates is warranted.

Capital market irregularities

If the Start program does truly help solve a capital market deficiency, continuity of Start in some form is desirable. However, given the high expected private returns to the funded R&D, scope may exist to design a more efficient support mechanism. One possibility is a HECS-type concessional loan. The potential recipients should be largely indifferent between receiving the funds in the form of a grant or being given a conditional loan, repayable only upon successful commercialisation and market development. The advantages would be that:

- the net cost in terms of public funds would be reduced;

- all allocated funds are likely to induce R&D and transfers are likely to be minimised;
- more, but smaller, allocations of funds are likely to be made and to be more effective;
- given high expected returns, and no downside risk to applicants, they should be willing to participate; and
- an automatic monitoring of the success of the program would be built in:
  - if rates of return truly are as high as anticipated, repayment of loans with interest would occur and, through time, the scheme could be expanded as required; or alternatively
  - if rates of return fall short of anticipated, failure of the scheme would eventually become apparent and it could be scaled back or eliminated.

An alternative instrument if communication is the problem

If the financing problem facing Start recipients is a communication issue, then government funds may be better targeted at this specific problem. Put another way, the current Start program is a very blunt instrument for dealing with communication issues. The same outcome could be achieved at considerably lower expense by providing direct education or marketing expertise to those seeking the funds.

The untested possibility that it is the application process that arms the firm with a business plan for developing and commercialising their concepts could be investigated. It may be that it is the attraction of the grant and the activities of consultants who encourage firms to apply that stimulates firms to engage in more innovative behaviour.

In written answers to the survey the recipients provided some support for this notion. Many non-recipients on the other hand indicated considerable frustration with the expense they incurred in applying for the grant, and were highly critical of AusIndustry and the Board's capacity to assess the technical complexity of their proposals.

Conclusions

Based on the survey data collected and analysed for this review, and in view of the sensitivity tests conducted, there appear to be two possible conclusions about the benefits and costs of the program.

- Assessed against the main rationale for R&D subsidies — knowledge spillovers — the net national benefits of the program are uncertain because of the wide range of estimates of spillovers.
- Assessed against the secondary rationale — capital market irregularities — the possibility exists that the net national benefits are very large, making the program potentially a very good investment for government.

However, direct R&D Start subsidies are a very blunt instrument for dealing with capital market irregularities if they exist.

Two main implications emerge:

- more evidence is required on whether capital market constraints are preventing profitable R&D from going ahead; and
- if they are, then the nature of the constraints needs to be closely identified and an efficient, well targeted policy instrument (probably not a direct subsidy) needs to be devised to deal with it, preferably one that is easy to monitor.

A further implication is that, given the uncertainty surrounding estimates of knowledge spillovers in the Australian economy, serious investigation into the robustness of such estimates is warranted.

Appendixes

A The benefit–cost framework

In order to understand the contribution that any particular piece of R&D makes, we need to track how R&D inputs, outputs and outcomes are transformed into private or public benefits (chart A.1).

Benefit–cost evaluation framework

The CIE benefit–cost evaluation framework has four essential components: existing data, survey data, economic models and a financial model.

- *Existing* and *survey data* is required to track how R&D inputs are transformed into R&D outputs and outcomes.
- *Economic models* are then required to transform R&D outputs and outcomes into direct, flow-on and spillover economic effects.
- A *financial model* is required to add up economic effects over time and to evaluate benefits relative to costs.

Key points to note about chart A.1 are the spillover effects such as the R&D that input into further R&D and the flow-on effects that are not captured directly by the returns to the firm. It is also important to note that the benefit measures go beyond the effect on GDP. They include measures of consumer surplus and, although not represented on the diagram, they also can include social and environmental outcomes and their value. Data on R&D inputs, outputs and outcomes were sourced from the survey and the existing AusIndustry Start database. Their impacts were calculated using the CIE version of the ORANI model of the Australian economy.

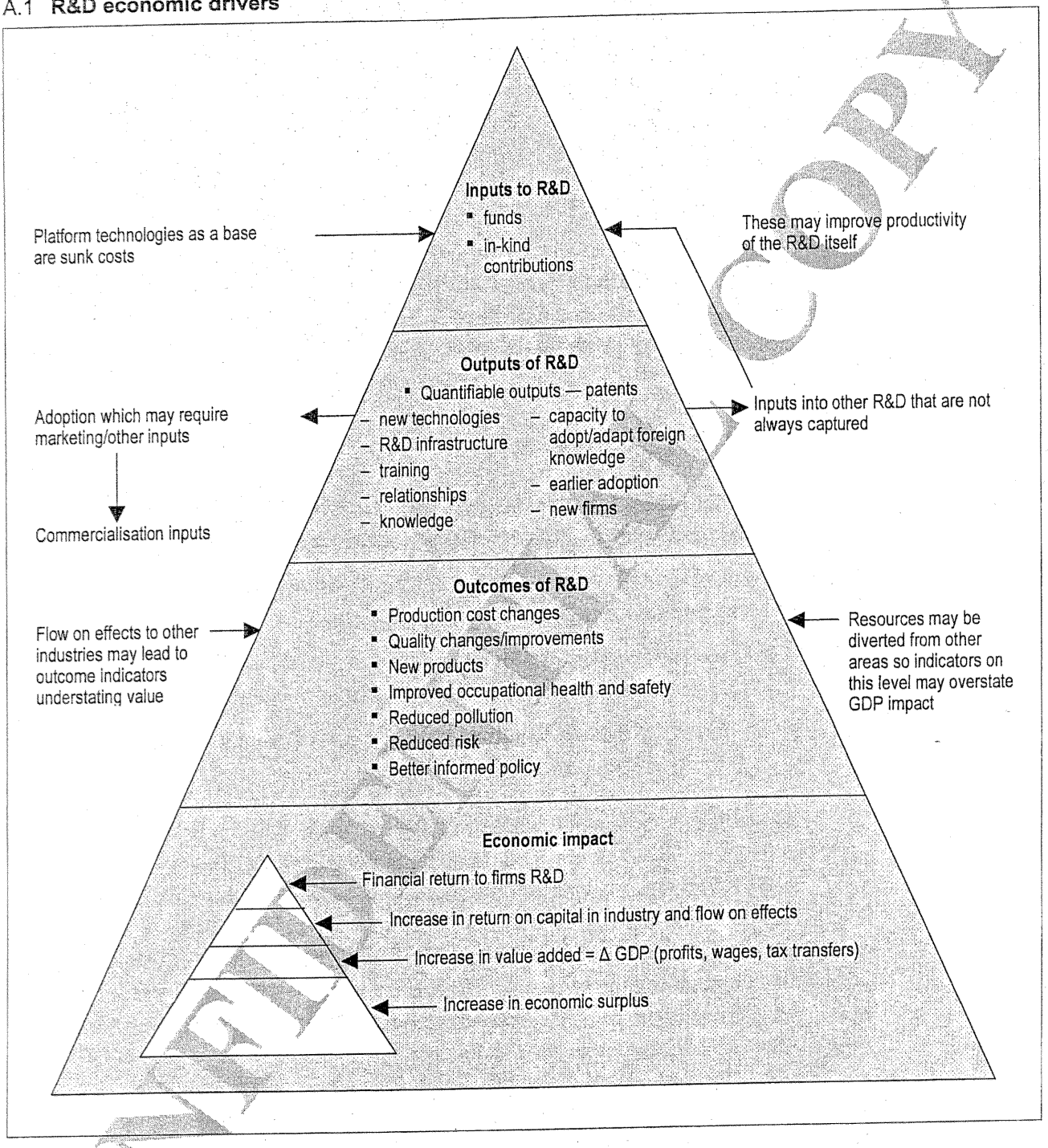
The broad benefit–cost framework is set out in chart A.2.

The questionnaire

Four written questionnaires were sent out to R&D Start applicants and recipients (see appendix B).

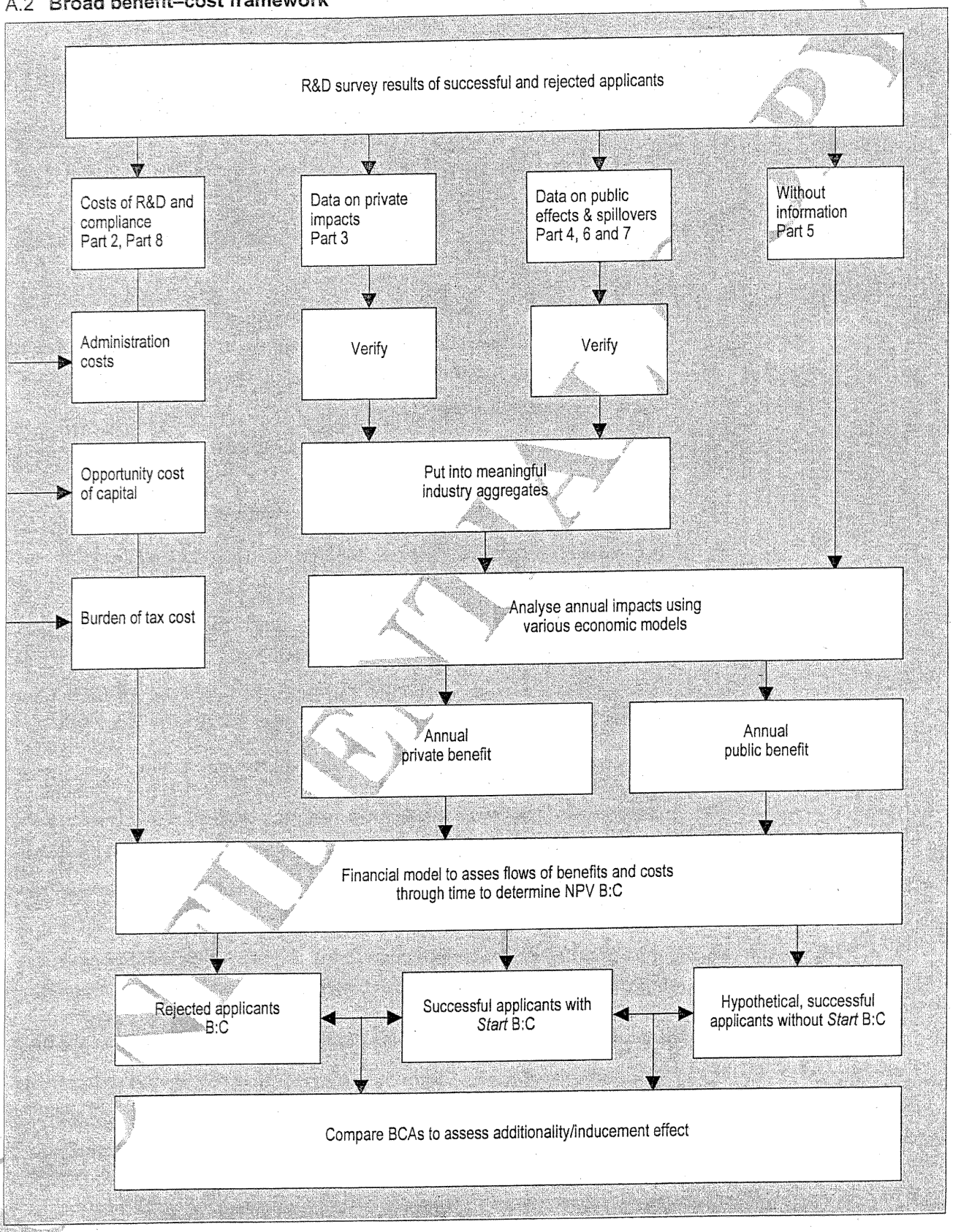
1. Recipients of Start grants.

A.1 **R&D economic drivers**



2. Start grant applicants whose applications were rejected — the control group.
3. Start Graduate Program users.
4. Recipients of Start Concessional Loans.

A.2 Broad benefit–cost framework



The questionnaires have many common elements structured around eight key parts.

- Part 1 relates to the age, size, structure and industry of the firm, and the R&D project that the Start grant was for.
- Part 2 relates to background information about the project supported by the Start grant – specifically, the technical success of the project and the expenditure on the project by stage and source of funds.
- Part 3 asks about the perceived current and future financial benefits from the R&D project.
- Part 4 relates to:
  - the impact of the R&D project on the firm, its customers and its competitors in Australia and abroad;
  - any IP generated from the project;
  - collaborations or joint ventures pursued as a result of the project; and
  - any flow-on economic impacts or innovations from the project.
- Part 5 asks about the impact on the R&D of the provision of the Start grant.
- Part 6 queries the reasons behind the lack of interest in the Start Graduate program.
- Part 7 queries the reasons behind the lack of interest in the Start Loan program.
- Part 8 relates to the compliance costs of the Start program.

The questionnaire for Start applicants whose applications were rejected asks fewer quantitative questions, but also asks some additional questions.

- Part 1 asks whether their planned project went ahead without Start funding, or if they invested in alternative R&D.
- Part 5 asks the respondent to speculate on how differently their projects performed or would have performed had they received a Start grant.

Graduate and loan questionnaires ask specific additional questions about:

- how involvement in the Start Graduate affected recipient's relationship with collaborating research institutions; and
- how the Start Loan program impacted on the recipient's capacity to obtain further funding.

The benefit–cost evaluation model

Cost of inputs information

Parts 2 and 8 of the survey collect specific cost information regarding the cost of inputs to the R&D, including the Start grant, the company's contribution to research and the cost of preliminary R&D, as well as the costs of commercialising and marketing the resulting product. The survey also queries what these funds were spent on — for example, capital goods, employment expenses and if a consortium of organisations collaborated on the research.

Other social costs such as the administrative cost of the program, the opportunity costs of the funds invested and the cost burden on the rest of the economy involved in raising these funds through taxes are accounted for using available estimates. Costs are accounted for in the financial model.

Outputs and outcomes of the R&D

The core part of the evaluation is to identify and quantify the private, flow-on and spillover benefits of the R&D supported by Start. This information is drawn mainly from parts 3 and 4 of the survey results. Answers to these two parts were checked for consistency and accuracy before being compiled into meaningful aggregates.

The analytical challenge

To assess the net additional economic benefits of the program requires comparing the benefits and costs of the funds invested through the program (the *with* situation) with the benefits and costs of:

- the R&D that would have occurred anyway without the program support (the *without* or *control* situation);
- the R&D conducted elsewhere in the economy and through alternative programs (an alternative without or control situation).

The differences define the net additional national benefits. Measuring the *without* or *control* situation is as important as measuring the *with* situation.

The *without* comparison comes from two sources. One is the responses from part 5 of the survey, which asks firms what R&D they would have undertaken under a range of hypothetical situations, including not receiving the Start grant. The other 'without comparison comes from the

survey of firms whose Start applications were not successful. These two sources provide a baseline or control for the evaluation of R&D benefits.

The impact of firm level R&D outcomes on their industry and the economy is analysed using various economic models and valuation techniques to produce annual benefit flows. In turn, these are fed into a financial model to estimate the present value of net benefits. Comparisons between the results for successful Start applicant, rejected Start applicants and what would have happened hypothetically to successful applicants without funding provide insights about the inducement and additionality effects of R&D Start funding.

The most important and difficult part of the evaluation is to quantify the benefits. Broadly speaking, there are two types of net benefits: private financial benefits to firms undertaking the R&D projects and spillover benefits.

The benefits to be measured

The various types of benefits from R&D to be measured are set out in chart A.3.

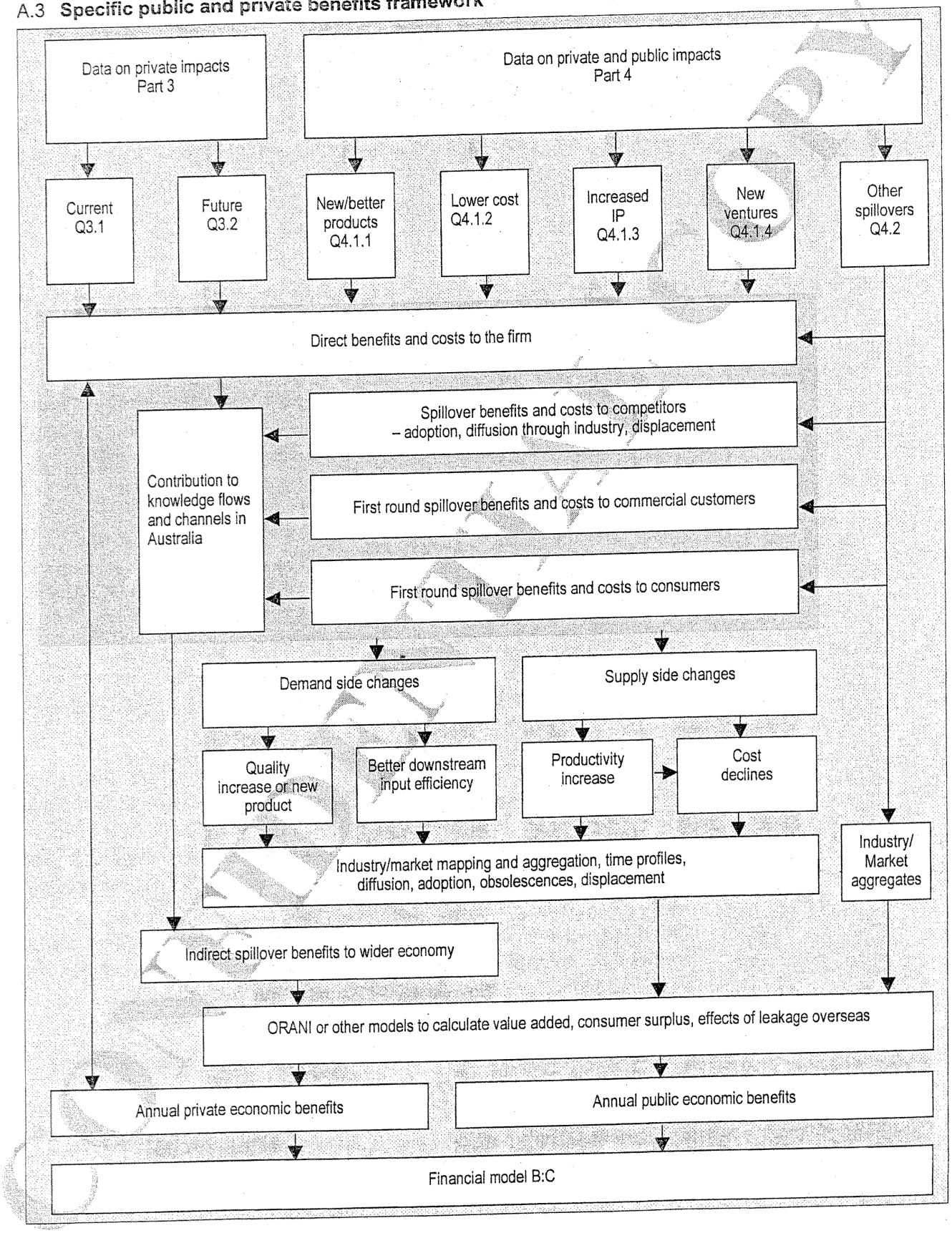
Direct benefits

Firms undertaking the R&D are expected to benefit directly from sales of a new or better product, the cost savings from a new production process, or through the sale of intellectual property they develop — chart A.3. Questions in part 3 and some questions in part 4 give information about these types of benefits.

Indirect benefits and impacts

Other questions in part 4 give information about flow-on and spillover benefits (chart A.3). The competitors of the firm in the same industry may get some flow-on benefit through adoption and diffusion of the new technology. However, they may also incur costs if their product is displaced in the market place. Commercial customers of the firm may receive flow-on benefits if the R&D project improves their input efficiency and/or the quality and market position of their own products. They may receive benefits in the form of the improvements in product quality and/or cheaper price.

A.3 Specific public and private benefits framework



In addition to these flow-on benefits is the possibility that further, broader spillover benefits could arise if the R&D projects make wider contributions to knowledge flows through the economy. R&D may spur on the development of further R&D or the development of other products, services or process in Australia. Questions included in part 4 of the questionnaire are designed to elicit information about the potential contribution to knowledge economies in Australia. These types of spillover will depend critically on the generality, applicability, intellectual property protection and potential rate of diffusion and uptake through the economy of the technology created.

The rate of spillover depends on how specific the knowledge is and how well it is protected. Protection can be formal through IPR, or ownership or control of an enabling technology or other critical input, or it can be informal due to the complexity of the process, reputation and relationships with major client groups. While protection may spur other R&D efforts if it affords the firm large profits, it slows the diffusion of the technology.

Indicators of or factors involved in high levels of spillover include mobility of trained staff between firms and between research, and commercial development of platform technologies, which need applications for them to have value and rapid rates of erosion of the competitive edge enabled by the technology.

Economies of scale and scope come from one firm's R&D efforts adding value to other firms R&D efforts. This can come about in a myriad of ways that include:

- development of a higher pool of skilled labour — both by providing training directly and by adding to the incentives for people to acquire skills and to locate in an area (this includes not only R&D skills but also management and marketing skills);
- building relationships between firms and research suppliers;
- providing critical mass of firms requiring services that are more relevant to innovating firms — venture capital services, marketing services, etc. — and lowering the transaction costs for other firms to engage in innovative activities; and
- stimulating innovation by changing attitudes to risk taking and managing risk of undertaking R&D and innovation.

Other flow-on effects include occupational health and safety, environmental benefits and cost and/or efficiency savings for public expenditure.

Estimating the direct and indirect effects

Many direct and flow-on outcomes of the R&D can be estimated and aggregated directly from the survey results. Based on such analysis, potential supply and demand changes to the economy can be formulated and simulated using economic models such as ORANI to generate economywide benefits and to ensure double counting is avoided.

Demand side changes mainly capture the benefits to commercial customers and consumers. Changes in demand are driven by higher input efficiency in the downstream industry, higher quality and/or new products. Supply side changes are cost reduction and productivity improvements. The market share of the firm undertaking the R&D project, the size of the industry, the life cycle of the products and the adoption profile of the new technology need to be taken into account to assess the changes to generate annual flows of both private and public benefits.

In addition to the simulation of economic models, existing and future benefits to the firm can be estimated directly from part 3 of the survey.

Estimating the likely spillover contribution from knowledge impacts is not easy. Some evidence (albeit controversial) of aggregate benefits of knowledge for the Australian economy exists. Some broad understanding of the microeconomic processes and factors that deliver benefits from knowledge also exists – however, many uncertainties remain. Nonetheless, by reference to benchmark studies of economywide effects and various indicators of the potential for knowledge spillovers from survey data, it is possible to speculate on these potential benefits.

Other spillover effects such as environmental, health and social benefits from question 4.2 of the survey will need to be aggregated and evaluated by reference to various benchmark studies. All benefits will be summed and compared with the R&D and various social costs.

B The questionnaires

The details of the four questionnaires issued to Start applicants and recipients are published in this appendix. The Start Grant and R&D or Business Venture questionnaires are shown in full. The Start Graduate and Loan program questionnaires are very similar to the Start Grant questionnaire, so only the questions that are different have been presented.

The order of the surveys and their explanations is:

- the Start Grant questionnaire;
- the Start Graduate program questionnaire;
- the Start Loan program questionnaire; and
- the R&D or business venture questionnaire (for applicants who were not granted Start funding)

Survey of R&D Start grant recipients

Part 1 About your firm

We need to understand a little bit about your firm in general, its R&D and its involvement with the R&D Start program.

1.1 Please enter your R&D Start program project number

1.2 Is your company a:
- public company? ☐
- private company? ☐

1.3 What percentage of your firm is foreign owned? %

1.4 Did you conduct this project collaboratively with other organisations? Yes ☐ No ☐ **Go to 1.5**

If yes, please select from the following

Other domestic company ☐
Other foreign company ☐
CRC/CSIRO ☐
University ☐
Other ☐ *Please specify*

1.5 How many people do you currently employ? *full-time equivalent*

1.6 Please indicate the turnover (total revenue) of your firm during the 2001-02 financial year $ million

1.7 What is the name of the R&D project for which your firm has received R&D Start assistance?

1.8 How much did you spend on R&D in total (R&D Start project plus any other) in 2001-02? $ million

1.9 Have you participated in any other government R&D programs? *Please specify* Year Program

1.10 How many extra staff did you employ to conduct the R&D project supported by the R&D Start program? person months *full-time equivalent*
– Are they still employed? Yes ☐ No ☐
– If no, please explain why

1.11 Since completing the project have you employed additional staff as a result of the project? Yes ☐ No ☐
If yes, give number

1.12 How much of the total R&D funding for the R&D Start-related project was invested in R&D plant and equipment? *Please give your best estimate.* $ million

Go to part 2

Part 2 Background information

We need to understand some details about the success of the project supported by the R&D Start program, the stages it has gone through towards commercialisation and the sources of funding for the R&D associated with the development of the project. Please fill out the following tables. *If actual data is not available, please give your best estimate.*

2.1 Technical success of your project by stages

	Stages			
	Concept and proof of concept	*Prototype*	*Commercial-isation*	*Market establishment*
What year was each stage completed? *If incomplete, please provide expected date of completion*				
Which stages have successfully met their objectives?	☐	☐	☐	☐
Which stages have partially met their objectives?	☐	☐	☐	☐
What is the expected probability of success of incomplete stages?	%	%	%	%
Which stages have failed to meet their objectives?	☐	☐	☐	☐
Did any stage exceed expected objectives?	☐	☐	☐	☐

2.2 Expenditure on R&D supported by R&D Start by stages. *Please give your best estimate.*

	Stages				
	Concept and proof of concept	*Prototype*	*Commer-cialisation*	*Market establishment*	*Total*
How much money did you receive from R&D Start for each stage?	$ m	$ m	$ m		$ m
How much has been invested from other sources for each stage?					
▪ Firm retained earnings	$ m	$ m	$ m	$ m	$ m
▪ Parent company funds	$ m	$ m	$ m	$ m	$ m
▪ Joint venture	$ m	$ m	$ m	$ m	$ m
▪ Public share issue	$ m	$ m	$ m	$ m	$ m
▪ Venture capital company	$ m	$ m	$ m	$ m	$ m
▪ Bank loan	$ m	$ m	$ m	$ m	$ m
▪ Own equity, including foregone wages	$ m	$ m	$ m	$ m	$ m
▪ Other, including other government assistance	$ m	$ m	$ m	$ m	$ m
Total investment from all sources	$ m	$ m	$ m	$ m	$ m

2.3	Did the project build on previous R&D undertaken by the firm that is not reflected in the stages indicated above?	Yes ☐ No ☐
	▪ If yes, please indicate the scale of previous investment	Total investment cost $
	▪ Duration of expenditure	years
2.4	Overall, do you consider the R&D project supported by the R&D Start program to be technically successful?	Yes ☐ → **Go to 3.1** No ☐ → **Go to 3.3**

Part 3 Financial benefits

For R&D regarded as having been successful, we need to obtain some information about the financial benefits your company has received as a result of the R&D project supported by R&D Start. By financial benefits, we mean how the R&D project has increased your profitability – that is, your revenues less any variable costs of manufacturing and marketing, and less the fixed investment costs of R&D and other initial commercialisation costs.

3.1 Please indicate the extent to which your company has received **additional accumulated financial benefits** (net profit), so far, from the R&D project conducted. Please select a box on the scale below to indicate your answer. *If unsure, please provide best estimate.*

☐ 0 — No financial benefit received so far

☐ 1 ☐ 2 ☐ 3 ☐ 4

☐ 5 — **Breakeven point, - covered total costs of R&D project only so far**

☐ 6 ☐ 7 ☐ 8 ☐ 9

☐ 10 — Highly profitable with accumulated financial benefits more than 20 times total costs of R&D project so far

3.2 Please indicate the extent to which you expect your company to receive **additional financial benefits** (net profit) in the next ten years from the R&D project conducted. Please select a box on the scale below to indicate your answer. *If unsure, please provide best estimate.*

☐ 0 — No financial benefit expected

☐ 1 ☐ 2 ☐ 3 ☐ 4

☐ 5 — **Breakeven point, - covered total costs of R&D project only**

☐ 6 ☐ 7 ☐ 8 ☐ 9

☐ 10 — Highly profitable with accumulated financial benefits more than 20 times total costs of R&D project

Go to part 4

3.3 Please indicate what factors limited the technical success of the project.

- Was more difficult technically than expected ☐
- Required more time and resources ☐
- Company priorities changed ☐
- Market priorities/circumstances changed ☐
- Other (*please specify*)

Go to part 4

Part 4 Economic effects

We need to understand the impacts that your R&D project could have on other firms and industries in the economy, whether it was technically successful or not. To do this, we need to understand something about the nature of the main impacts of your R&D project. Even if the R&D project was not technically successful, some spillover benefits may have helped you or others.

4.1 Please indicate the main economic outcomes of your R&D Start -supported R&D project. We would expect there to be a maximum of three strong economic outcomes. *Please select a box to indicate your response and, where you select 'strong' for any impact, complete the additional part 4 questions listed in the last column of this table. Please complete this question 4.1 before proceeding to the additional part 4 questions.*				
	Degree of impact (please select most appropriate)			*Question to be completed if 'strong' was selected*
Area of impact	*None*	*Some*	*Strong*	
a. Development of a new product/service/process	☐	☐	☐	4.1.1
b. Development of a better product/service/process	☐	☐	☐	4.1.1
c. Reduced costs of production due to new/better process	☐	☐	☐	4.1.2
d. Increased intellectual property of your company	☐	☐	☐	4.1.3
e. Increased the opportunities for your company to engage in new ventures/collaborations	☐	☐	☐	4.1.4

4.1.1 If you selected 'Strong' at 4.1a or b, because your R&D Start-supported R&D project has led to development of a new or better product/service/process, we need to understand something about the nature of that product, who it is sold to and what benefit it is to them.

Briefly describe the new/better product

Who are your customers?

- Other industries. Please enter appropriate code number(s) from attachment A at page 12.
- Household consumers. Please enter appropriate code number(s) from attachment B at page 13.

Does your product:

- create an entirely new market? No ☐ Yes ☐
- create a new segment in an existing market? No ☐ Yes ☐
- replace a product you previously produced? No ☐ Yes ☐
- replace a product produced by competitors? No ☐ Yes ☐

Please indicate the current size of the market you sell your new/better product to, the market share of your new/better product and your net profit margin on these sales. *If unsure, please provide your best estimate.*

Market sold to	*Value*	*Your market share*	*Your net profit margin (specify if >10%)*
Australia ☐	$ m/yr	%	☐ 0–2% ☐ 3–5% ☐ 6–10% or specify
Overseas ☐	$ m/yr	%	☐ 0–2% ☐ 3–5% ☐ 6–10% or specify

Please indicate the expected size of the market in five years time. *If unsure, please provide your best estimate.*

Market sold to	*Value*	*Your market share*	*Your net profit margin (specify if >10%)*
Australia ☐	$ m/yr	%	☐ 0–2% ☐ 3–5% ☐ 6–10% or specify
Overseas ☐	$ m/yr	%	☐ 0–2% ☐ 3–5% ☐ 6–10% or specify

What is the value of your product to your customers? *Please give your best estimate.*

Are customers prepared to pay a premium price for your product compared with competitors' products or a product you previously produced? ☐ Don't know No ☐ Yes ☐ Price premium %

Does it reduce costs to business customers in their operation? ☐ Don't know No ☐ Yes ☐

If yes, please indicate your best estimate of the cost reduction to all your business customers.

☐ $0–1m/yr ☐ $2–5m/yr ☐ $6–20m/yr ☐ $21–100m/yr ☐ Greater than $100m/yr

Does it increase the quality of output of your business customers? ☐ Don't know No ☐ Yes ☐

Are customers switching to your product in preference to a competitor's product or a product you previously produced? Don't know ☐ No ☐ Yes ☐ Sales value switched $ million/year

Has the R&D Start-supported R&D project increased your sales overall? ☐ Don't know No ☐ Yes ☐ Growth in sales % increase

How long before you lose your competitive edge to rivals, assuming you do no further research?
☐ 1 year ☐ 2 years ☐ 5 years ☐ 10 years ☐ More than 10 years

How long before you lose your competitive edge to rivals, assuming ongoing R&D?
☐ 1 year ☐ 2 years ☐ 5 years ☐ 10 years ☐ More than 10 years

Is ongoing R&D to maintain your competitive edge sustainable without further government assistance? No ☐ Yes ☐

4.1.2 If you selected 'Strong' at 4.1c, because your R&D Start-supported R&D project has helped you develop cost saving technologies, we need to understand the extent of these savings and their potential diffusion through the industry.

How has the R&D project led to reduced costs of production or operation for you?

How much has the new technology lowered your costs of production and/or operation? Please indicate your best estimate of the percentage reduction in your total production costs.

☐ 0–1% ☐ 2–5% ☐ 6–10% ☐ 11–20% ☐ Greater than 20% specify %

Have you lowered your price to customers as a result? No ☐ Yes ☐

How applicable is the new technology to competitors in your industry?

Market	Entire industry	*¾ industry*	*½ industry*	*¼ industry*	*Smaller % (indicate)*	*What is the size of your industry*
Australia	☐	☐	☐	☐		$ m sales/yr
Overseas	☐	☐	☐	☐		$ m sales/yr

How long before you lose your competitive edge to rivals, assuming you do no further research?

☐ 1 year ☐ 2 years ☐ 5 years ☐ 10 years ☐ More than 10 years

How long before you lose your competitive edge to rivals, assuming ongoing R&D?

☐ 1 year ☐ 2 years ☐ 5 years ☐ 10 years ☐ More than 10 years

Is ongoing R&D to maintain your competitive edge sustainable without further government assistance? No ☐ Yes ☐

4.1.3 If you selected 'Strong' at 4.1d, because intellectual property (IP) has been generated through your R&D Start-supported R&D project, we need to understand some aspects of its protection and potential value.

Is your R&D protected from being copied by any of the following?

- 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 ☐
- Other? (please specify)

If possible, please indicate your best estimate of the value of your IP over the next 10 years.

☐ $0–1 million ☐ $2–5 million ☐ $6–20 million ☐ $21–100 million ☐ Greater than $100 million

Is this from:

☐ increased sales of a product/service/process? ☐ licence fees or royalties ☐ other *(please specify)*

4.1.4 If you selected 'Strong' at 4.1e, because your R&D Start-supported R&D project has helped you to pursue further R&D and/or business ventures/collaborations, we need to understand the extent of this.
Where specific numbers are requested, please supply best estimates

	New R&D	*Market development*	*Expanded production*	*Other Please specify*
How many of the following ventures/collaborations have you pursued?				
What is the additional investment as a result of these ventures?	$ m	$ m	$ m	$ m
Please indicate source of funding: retained earnings venture capital loans public equity other, *please specify*	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
Please indicate collaboration with others: research institutions other domestic firms foreign firms other, *please specify*	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
Can you put a value on the potential benefits you expect from this venture in the next 10 years?	☐ Don't know $ m	☐ Don't know $ m	☐ Don't know $ m	☐ Don't know $ m
What is your estimate of the probability of you realising these benefits?	%	%	%	%

Is any R&D infrastructure developed for your R&D Start-supported project being used for ongoing R&D? No ☐ Yes ☐

4.2 Please indicate if there have been any other significant flow-on economic impacts or innovations from your R&D Start-supported R&D that have impacted on your firm, other firms in your industry and firms outside your industry. We would expect there would be fewer than three significant outcomes.
Please select a box to indicate which entities have been affected by spinoff innovations and provide your best estimates of the type and magnitude of impact in the table below.

Area of impact	*Significant impact on: (select only those appropriate)*			*Type and magnitude of impact (please give best estimates)*	
	Own firm	*Firms in industry*	*Other industries*		
a. Reduced occupational health/safety (OHS) hazard	☐	☐	☐	Can you put a value on the cost of the OHS risks impacted upon?	☐ Don't know $ /year
				What is the reduction in OHS risk as a result of the technology?	☐ Don't know % decline
b. Reduced pollution	☐	☐	☐	What is the cost of pollution impacted upon?	☐ Don't know $ /year
				What is the reduction in cost as a result of the technology?	☐ Don't know % decline
c. Reduced company/ industry risk	☐	☐	☐	Can you put a value on the cost of risk impacted upon?	☐ Don't know $ /year
				What is the reduction in risk as a result of the technology?	☐ Don't know % decline
d. Increased skills of employees	☐	☐	☐	Have the increased skills of employees enabled an increase in profitability?	☐ Don't know % increase
				Have you lost staff as a result of their increased skills?	☐ Don't know people
e. Development of a new or improved platform technology	☐	☐	☐	What is/will be the maximum adoption rate outside of your firm?	☐ Don't know % market
				How many years until maximum adoption is reached?	☐ Don't know years
f. Other impacts, such as helping to create a necessary critical mass for a start up industry or new spinoff companies. *Please specify.*					

Go to part 5

Part 5 Influence of R&D Start funds

To assess the impact of the R&D Start program and its value to you, we are keen to know, in a *hypothetical* sense, how changes in R&D Start funding might affect you.

5.1 Please answer the following questions to provide us with an understanding of the effects of *hypothetical* changes in Start funding. *If unsure, please provide best estimate.*

Were the R&D Start program funds you received sufficient to conduct your R&D project efficiently and expeditiously? No ☐ Yes ☐

What did you think was the probability of financial success when you started the R&D Start-supported R&D project? %

Hypothetically, had you received twice as much R&D Start-supported R&D project funding as you did (and with no requirement from you to make matching funding), would this have allowed you to: *Please give your best estimate.*

- expand the scope of the project? No ☐ Yes ☐ % increase
- increase the R&D outcomes and benefits? No ☐ Yes ☐ % increase
- increase the probability of success? No ☐ Yes ☐ from % to %
- reduce the alternative financing needed? No ☐ Yes ☐ % decrease
- decrease time to reach commercialisation? No ☐ Yes ☐ years

Hypothetically, if, instead of a R&D Start grant, you had been offered a concessional loan, which was only repayable upon commercial success of the R&D, would you have: *If no, please explain why*

- taken up the loan and proceeded with the project? No ☐ Yes ☐
- proceeded with the project with alternative funds? No ☐ Yes ☐

Hypothetically, had R&D Start program funds not been made available, would this have:

- delayed the time to commercialisation? No ☐ Yes ☐ years delay
- reduced funding from alternative sources? No ☐ Yes ☐ % decline
- increased the cost to you of the R&D? No ☐ Yes ☐ % increase
- affected the probability of success? No ☐ Yes ☐ from % to %
- reduced the scope of the project? No ☐ Yes ☐ % decline
- reduced the R&D outcomes and benefits to you? No ☐ Yes ☐ % decline
- allowed competitors to reduce your lead to market? No ☐ Yes ☐ years

What financial obstacle(s) did your R&D project face when you first applied for R&D Start funding?

5.2 Do you have anything further to add about the main benefits of the R&D Start program to your company, your industry or the economy more generally? If you received R&D Start Premium, please comment on its value to you.

5.3 Do you have any comments about ways of improving the R&D Start program?

Part 6 R&D Start Graduate program

The R&D Start Graduate program has not been widely taken up by industry. We need to assess why firms have not been interested, as well as the benefits to firms who have been involved in the program.

6.1 If you have not been involved in the R&D Start Graduate program, we need to understand why.		
Have you been involved in the R&D Start Graduate program?	No ☐ → **Please go to 6.2**	Yes ☐ → **Please also complete the R&D Start Graduate questionnaire**

6.2 If you answered no to 6.1, we would like to understand why you have not been involved in the R&D Start Graduate program. *Please select all options relevant to you.*	
▪ Not aware of the program	☐
▪ Management requirements too onerous relative to potential benefit	☐
▪ No desire to form a collaboration with a research institution through such a 'joint' project	☐
▪ Difficulty in finding a university willing to commit resources to the project	☐
▪ Structure of the program limits the potential for firm-driven research	☐
▪ Resources delivered by the program are insufficient to fund R&D that would have an impact on firm performance	☐
▪ Other (*please specify*)	

Part 7 The R&D Start Loan program

The R&D Start Loan program has not been widely taken up by industry. This program provides concessional loans to companies that employ fewer than 100 persons and which are involved in the early commercialisation of technological innovations. Projects must be completed within three years and must be repaid in the following three years. We need to assess why firms have not been interested as well as the benefits to firms who have been involved in the program.

7.1 If you have not been involved in the R&D Start Loan program, we need to understand why.		
Have you been involved in the R&D Start Loan program?	No ☐ → **Please go to 7.2**	Yes ☐ → **Please also complete the R&D Start Loan questionnaire**

7.2 If you answered no to 7.1, we would like to understand why you have not been involved in the R&D Start Loan program. *Please select all options relevant to you.*	
▪ Not aware of the program	☐
▪ Do not qualify for the program (more than 100 employees)	☐
▪ Not able to qualify as have access to alternative sources of loan finance	☐
▪ Costs (administrative, compliance etc.) of the loan do not make it attractive	☐
▪ Prefer venture capital on the funds where they offer services as well as access to loans	☐
▪ Other (*please specify*)	

Part 8: Compliance costs

We need to take account of all costs of the program including the cost to you of complying.

8.1 Please provide your best estimate of the costs to your company in meeting the requirements for application and administration of the R&D Start grant	
Cost of applying for R&D Start grant	$
Costs incurred during administration of grant	$
Other costs	$
Total	**$**

Please indicate the time it took you to complete this questionnaire — hours, minutes.

The Start Graduate questionnaire

The Start Graduate Questionnaire is identical to the start Grant questionnaire for questions 1, 2, 3 and 4. Questions 4 and 6 for the Graduate questionnaire are produced below. The Graduate questionnaire had no question 7 or 8.

Part 5: Impact on collaboration

We are keen to know how involvement in the program impacted on your relationship with the research institution and gain an understanding of the sources of value from collaboration.

5.1 Please answer the following questions to provide us with an understanding of the impact on collaboration.

Did your firm have a relationship with the research institution prior to applying for the R&D Start Graduate program that provided the graduate?	☐ No	☐ Yes, in the project research field ☐ Yes, but not in the project research field
Did you know the graduate prior to the application for the Start grant?	☐ No	☐ Yes
How did the linkages/collaboration start?	Initiated by the graduate	☐
	Initiated by your firm	☐
	Initiated by the research institution	☐
	Other (*please specify*)	
What access to expertise in the research institution was facilitated by your involvement in the program?	None	☐ **Go to 5.2**
	Only project related contact	☐
	Limited additional contact	☐
	Significant additional contact	☐
Has this contact led to any further R&D collaboration between the research institution and your firm?	No ☐ Yes ☐	Size of R&D projects $ Years
Do you think that collaboration will continue in the future?	No ☐ Yes ☐	If so, in what form

5.2 Please answer the following questions to provide us with an understanding of the sources of impact in collaboration. Please select a box to indicate your response.

Source of value	*Value (please select most appropriate)*		
	Low	*Medium*	*High*
Source of new ideas	☐	☐	☐
Lower cost access to expert opinion	☐	☐	☐
Lower cost access to technical equipment	☐	☐	☐
More cost effective R&D	☐	☐	☐
Speeding up of R&D results	☐	☐	☐
Identify high quality future employees	☐	☐	☐
Other (please specify)	☐	☐	☐
Other (please specify)	☐	☐	☐
Other (please specify)	☐	☐	☐

5.3 The following questions provide us with an understanding of subsequent employment of graduates.			
Has the graduate employed through the program subsequently been employed by your firm?	☐ No	☐ Yes, but has since left	☐ Yes, and is still employed
To the best of your knowledge, has the graduate:	▪ gone on to further study?		☐
	▪ been employed by a research institution?		☐
	▪ been employed in your industry?		☐
	▪ been employed in another industry?		☐
	▪ other? (*please specify*)		
	▪ don't know		

5.4 Why did you chose the Graduate Start option?

5.5 Do you have anything further to add about the main benefits of the R&D Start program to your company, your industry or the economy more generally?

5.6 Do you have any comments or suggestions for improving the R&D Start Graduate program?

Part 6: Compliance costs

We need to take account of all costs of the program including the cost to you of complying.

6.1 Please provide your best estimate of the costs to your company in meeting the requirements for application and administration of the R&D Start grant	
Cost of applying for R&D Start grant	$
Costs incurred during administration of grant	$
Other costs	$
Total	**$**

Please indicate the time it took you to complete this questionnaire – hours, minutes.

R&D Start Loan questionnaire

The Start Loan Questionnaire is identical to the Start Grant questionnaire for questions 1, 2, 3 and 4. Questions 4 and 6 for the Loan questionnaire are produced below. The Loan questionnaire had no question 7 or 8.

Part 5: Impact on capacity to raise funds

The R&D Start Loan program is designed to assist small firms to access finance for commercialisation. We are keen to know how involvement in the program impacted on your capacity to attract other sources of funding.

5.1 Please answer the following questions to provide us with an understanding of the impact on access to finance.

What were the main reasons why your firm was not able to access commercial funding for the project supported by the R&D Start Loan? (Please indicate all relevant answers)

- Project viewed as too risky ☐
- Lack of sufficient collateral ☐
- Lack of resources to prepare a business plan acceptable to financiers ☐
- Other (*please specify*)

Has your R&D Start loan increased your capacity to access other sources of finance?

No ☐ **Please go to 5.2**

Yes ☐ Please indicate what type:

- Concurrent loans ☐
- Follow-on loans ☐
- Equity ☐
- Other (*please specify*)

What are the main aspects of the R&D Start Loan that have lead to greater access to finance? (Please indicate all relevant answers)

- Commercial success of the venture and associated revenue stream ☐
- Improved skills in preparing loan applications ☐
- Reputation enhanced by being awarded a R&D Start Loan ☐
- Other (*please specify*)

5.2 The R&D Start Loan program was intended to become self supporting over time, yet it also funds relatively 'high risk' projects. To help us understand whether this concept is viable we would like to know something about your repayments.		
What stage in your loan are you at?	Repayments yet to start	☐
	Period repayments commenced	☐
Have you been able to, or anticipate being able to, make repayments?	Yes, all as scheduled	☐
	Yes, but with minor rescheduling	☐
	Yes, but with major rescheduling	☐
	No, not at all	☐
If you have not been able to make all repayments as originally scheduled, or anticipate that you will not be able to, what are the main reasons?	Project failed	☐
	Project took longer to complete than anticipated	☐
	Company failed	☐
	Other (*please specify*)	
What has been/will be the source of funds for repayments?	Sales revenue	☐
	Other loans	☐
	Equity investment	☐
	Other (*please specify*)	

5.3 Do you have anything further to add about the main benefits of the R&D Start program to your company, your industry or the economy more generally?

5.4 Do you have any comments or suggestions for improving the R&D Start Loan program?

Part 6: Compliance costs

We need to take account of all costs of the program including the cost to you of complying.

6.1 Please provide your best estimate of the costs to your company in meeting the requirements for application and administration of the R&D Start Loan	
Cost of applying for R&D Start Loan	$
Costs incurred during administration of Loan	$
Other costs	$
Total	$

Please indicate the time it took you to complete this questionnaire — hours, minutes.

R&D or Business Venture questionnaire

The R&D or business venture questionnaire excluded many quantitative questions.

Part 1 About your firm

We need to understand a little bit about your firm in general and its R&D.

1.1 Is your company a:	▪ public company? ☐ ▪ private company? ☐	
1.2 What percentage of your firm is foreign owned?	%	
1.3 Are you conducting R&D collaboratively with other organisations?	Yes ☐ No ☐ **Go to 1.5** *If yes, please select from the following*	
	Other domestic company	|
	Other foreign company	|
	CRC/CSIRO	|
	University	|
	Other	| *Please specify*
1.4 How many people do you currently employ?	*full-time equivalent*	
1.5 Please indicate the turnover (total revenue) of your firm during the 2001-02 financial year	$ million	
1.6 What is the name of the R&D project for which your firm applied for R&D Start assistance?		
1.7 How much did you spend on R&D in total in 2001-02?	$ million	
1.8 Which of the following elements of the R&D Start program did you apply for and in which year(s)?	Core ☐	Year(s)
	Premium ☐	Year(s)
	Plus ☐	Year(s)
	Graduate ☐	Year(s)
	Concessional loan ☐	Year(s)
1.9 In the absence of the R&D Start funds, did you continue with your original R&D idea anyway?	No ☐ ↓ **Please continue**	Yes ☐ ↓ **Go to part 2**
1.10 Did you pursue an alternative R&D project?	No ☐	Yes ☐
1.11 Did you invest the funds that you would have invested in an R&D project into an alternative business venture?	No ☐	Yes ☐

If you have answered 'no' to the last three questions, please go to question 5.3.

Part 2 Background information

We need to understand some details about the success of your original R&D and alternative R&D or other business project, the stages it has gone through towards commercialisation and the sources of funding for it. Please fill out the following tables. *If actual data is not available, please give your best estimate.*

2.1 Technical success of your R&D project or alternative project by stages

	Stages			
	Concept and proof of concept	*Prototype*	*Commercial-isation*	*Market establishment*
What year was each stage completed? *If incomplete, please provide expected date of completion*				
Which stages have successfully met their objectives?	☐	☐	☐	☐
Which stages have partially met their objectives?	☐	☐	☐	☐
What is the expected probability of success of incomplete stages?	%	%	%	%
Which stages have failed to meet their objectives?	☐	☐	☐	☐
Did any stage exceed expected objectives?	☐	☐	☐	☐

2.2 Expenditure on R&D project or alternative project by stages. *Please give your best estimate.*

	Stages				
	Concept and proof of concept	*Prototype*	*Commer-cialisation*	*Market establishment*	*Total*
How much has been invested from various sources for each stage of your R&D or alternative venture?	$ m	$ m	$ m	$ m	$ m

2.3 Did the project build on previous R&D undertaken by the firm that is not reflected in the stages indicated above? Yes ☐ No ☐

- If yes, please indicate the scale of previous investment — Total investment cost $
- Duration of expenditure — years

2.4 Overall, do you consider your original R&D project and alternative R&D project or other business venture to be technically successful? Yes ☐ **Go to 3.1** No ☐ **Go to 3.3**

Part 3 Financial benefits

For your original R&D project, and alternative R&D and business ventures regarded as successful, we need to obtain some information about the financial benefits your company has received. By financial benefits, we mean how the R&D and business ventures have increased your profitability – that is, your revenues less any variable costs of manufacturing and marketing, and less the fixed investment costs of R&D and other initial commercialisation costs.

3.1 Please indicate the extent to which your company has received **additional accumulated financial benefits** (net profit), so far, from the R&D or alternative business venture project conducted. Please select a box on the scale below to indicate your answer. *If unsure, please provide best estimate.*

☐ 0 — No financial benefit received so far

☐ 1 ☐ 2 ☐ 3 ☐ 4

☐ 5 — **Breakeven point, - covered total costs of R&D project only so far**

☐ 6 ☐ 7 ☐ 8 ☐ 9

☐ 10 — Highly profitable with accumulated financial benefits more than 20 times total costs of R&D project so far

3.2 Please indicate the extent to which you expect your company to receive **additional financial benefits** (net profit) in the next ten years from the R&D or alternative project conducted. Please select a box on the scale below to indicate your answer. *If unsure, please provide best estimate.*

☐ 0 — No financial benefit expected

☐ 1 ☐ 2 ☐ 3 ☐ 4

☐ 5 — **Breakeven point, - covered total costs of R&D project only**

☐ 6 ☐ 7 ☐ 8 ☐ 9

☐ 10 — Highly profitable with accumulated financial benefits more than 20 times total costs of R&D project

Go to part 4

3.3 Please indicate what factors limited the technical success of the R&D or alternative business project.

- Was more difficult technically than expected? ☐
- Required more time and resources ☐
- Company priorities changed ☐
- Market priorities/circumstances changed ☐
- Other (*please specify*)

Go to part 4

Part 4 Economic effects

We need to understand the impacts that your original R&D, alternative R&D or other business venture could have on other firms and industries in the economy, whether it was technically successful or not. To do this, we need to understand something about the nature of the main impacts of your R&D project. Even if the R&D was not technically successful, some spillover benefits may have helped you or others.

4.1 Please indicate the main economic outcomes of your R&D or alternative business venture. We would expect there to be a maximum of three strong economic outcomes. *Please select a box to indicate your response and, where you select 'strong' for any impact, complete the additional part 4 questions listed in the last column of this table. Please complete this question 4.1 before proceeding to the additional part 4 questions.*

Area of impact	*Degree of impact (please select most appropriate)*			*Question to be completed if 'strong' was selected*
	None	*Some*	*Strong*	
a. Development of a new product/service/process	☐	☐	☐	4.1.1
b. Development of a better product/service/process	☐	☐	☐	4.1.1
c. Reduced costs of production due to new/better process	☐	☐	☐	4.1.2
d. Increased intellectual property of your company	☐	☐	☐	4.1.3

4.1.1 If you selected 'Strong' at 4.1a or b, because your R&D project or alternative business venture has led to development of a new or better product/service/process, we need to understand something about the nature of that product, who it is sold to and what benefit it is to them.

Briefly describe the new/better product

Does your product:

- create an entirely new market? No ☐ Yes ☐
- create a new segment in an existing market? No ☐ Yes ☐
- replace a product you previously produced? No ☐ Yes ☐
- replace a product produced by competitors? No ☐ Yes ☐

What is the value of your product to your customers?

- Are customers prepared to pay a premium price for your product compared with competitors' products or a product you previously produced? Don't know ☐ No ☐ Yes ☐
- Does it reduce costs to business customers in their operation? Don't know ☐ No ☐ Yes ☐
- Does it increase the quality of output of your business customers? Don't know ☐ No ☐ Yes ☐
- Are customers switching to your product in preference to a competitor's product or a product you previously produced? Don't know ☐ No ☐ Yes ☐
- Has the R&D or alternative business venture increased your sales overall? Don't know ☐ No ☐ Yes ☐

4.1.2 If you selected 'Strong' at 4.1c, because the R&D project or an alternative business venture has helped you develop cost saving technologies, we need to understand the extent of these savings and their potential diffusion through the industry.

How has the R&D project or alternative business venture led to reduced costs of production or operation for you?

How much has the new technology lowered your costs of production and/or operation? Please indicate your best estimate of the percentage reduction in your total production costs. Don't know ☐

☐ 0–1% ☐ 2–5% ☐ 6–10% ☐ 11–20% ☐ Greater than 20% specify %

Have you lowered your price to customers as a result? No ☐ Yes ☐

4.1.3 If you selected 'Strong' at 4.1d, because intellectual property (IP) has been generated through your R&D project or alternative business venture, we need to understand some aspects of its protection and potential value.

Is your R&D protected from being copied by any of the following?

- 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 ☐
- Other? (*please specify*)

4.2 Please indicate if there have been any other significant flow-on economic impacts or innovations from your R&D project or alternative business venture that have impacted on your firm, other firms in your industry and firms outside your industry. We would expect there would be fewer than three significant outcomes.
Please select a box to indicate which entities have been affected by spinoff innovations and provide your best estimates of the type and magnitude of impact in the table below.

Area of impact	*Significant impact on: (select only those appropriate)*		
	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*)			

Part 5 Influence of R&D Start funds

To assess the impacts of the R&D Start program, we are keen to understand, in a *hypothetical* sense, what impact the absence of a R&D Start grant might have had on your R&D and other business activities.

5.1	Please answer the following questions to provide us with an understanding of the effects of you missing out on a grant. *If unsure, please provide best estimate.*		
	On missing out on the R&D Start funds, did you seek out and receive sufficient funds to conduct your R&D project efficiently and expeditiously?	No ☐ Yes ☐	
	What did you think was the probability of financial success when you started your R&D or alternative business venture?	%	
	Hypothetically, had you received R&D Start-funding would this have allowed you to:		Please give your best estimate.
	▪ expand the scope of the project?	No ☐ Yes ☐	
	▪ increase the R&D outcomes and benefits?	No ☐ Yes ☐	
	▪ increase the probability of success?	No ☐ Yes ☐	
	▪ reduce the alternative financing needed?	No ☐ Yes ☐	% decrease
	▪ decrease time to reach commercialisation?	No ☐ Yes ☐	years
	What financial obstacle(s) did your R&D project face when you first applied for R&D Start funding?		
	If R&D Start provided funds to your competitors, how did this affect your R&D or alternative business venture?	*Please explain*	

5.2	Do you have anything further to add about the main benefits that would have been received by your company had you received R&D Start funding?

5.3	Do you have any comments about ways of improving the Start program?

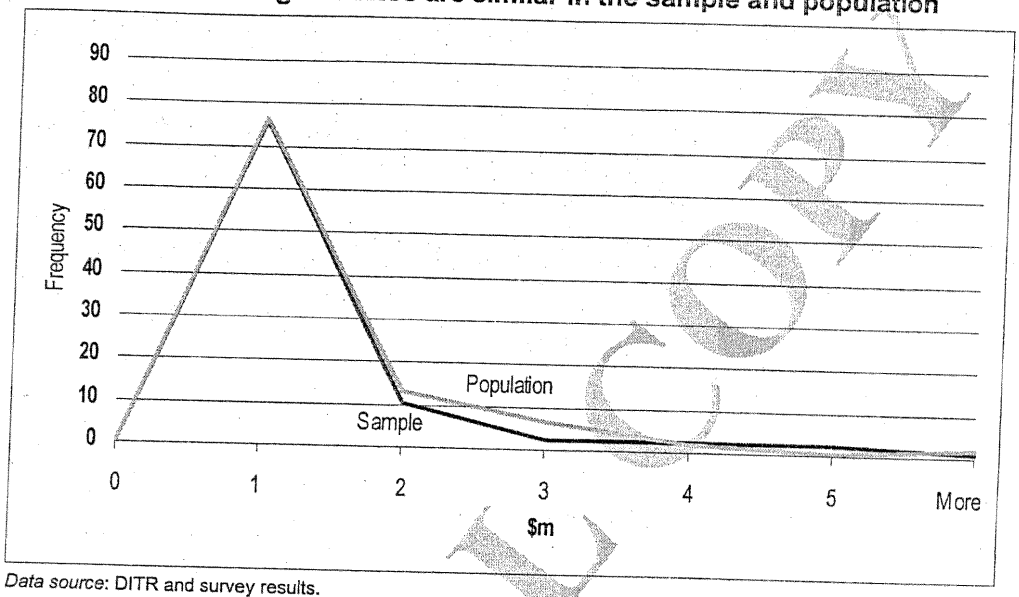
Please indicate the time it took you to complete this questionnaire — hours, minutes.

C The survey response provides a representative sample

Based on several key parameters, the sample appears to provide a good representation of the population.

- Statistically:
  - we can be 99 per cent sure that there is no difference between the mean grant size of the sample and the mean grant size of the population; and
  - that the distribution of grant size for the sample and population are very close as shown in chart C.1.
- We also have an appropriate representation of firm sizes in the sample, and can be 99 per cent sure that the average number of employees and turnover of grant recipients in the samples is not different from the same measure for the population.
- Across sectors, we have good representation of all seven major sectors and five smaller sectors, with another seven minor sectors being under-represented. However, some of the minor sectors are so small that this is unavoidable (chart C.2).
- By elements of the program, grants, rejects, graduates and loans are reasonably represented (chart C.3).
- Proportions of technically successful and technically unsuccessful recipients suggests some bias (chart C.4).
  - DITR data suggests that 14 per cent of the population were technically unsuccessful, but only around 4 per cent of returns fall in this same category using DITR indicators of technical failure, while around 1 per cent of returns fit this category based on firms' own indicators.
  - However, the main bias created by this under-representation relates to an under-representation of costs only, since benefits of technically unsuccessful recipients are likely to be minor — this can be corrected for reasonably easily.

C.1 **Distribution of grant sizes are similar in the sample and population**



Data source: DITR and survey results.

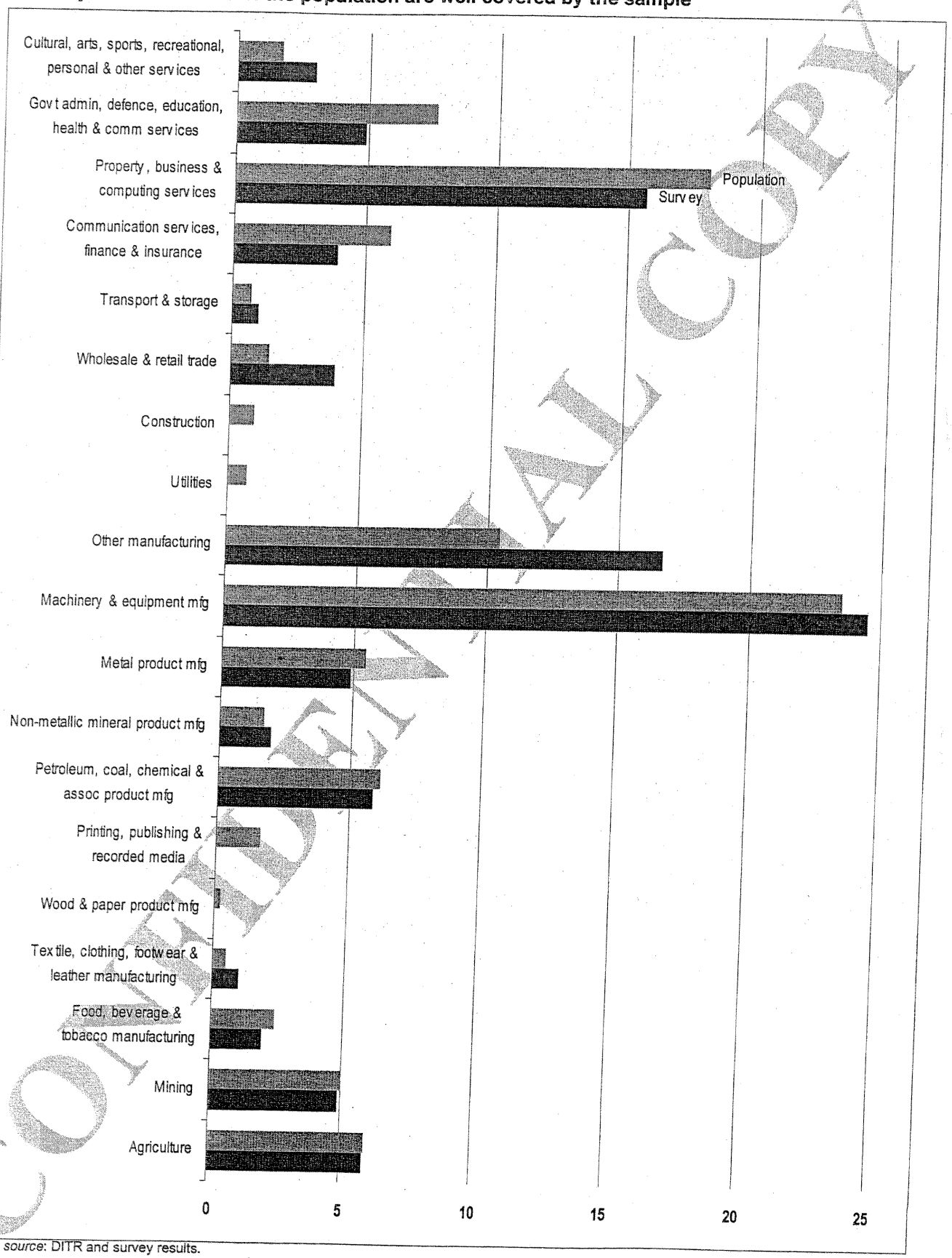
Comparison with the failed control group

The reasons of the two reviewers for rejecting the surveyed non-recipients as a control group are set out in box C.5. The eligibility problems mentioned indicate that it will always be difficult to identify a valid control group.

At the time of selecting the sample for the proposed control group, we did not have full information on the profile of the non-recipient group. With more time to construct a control and with more careful selection, future reviews may be able to establish a reliable control group.

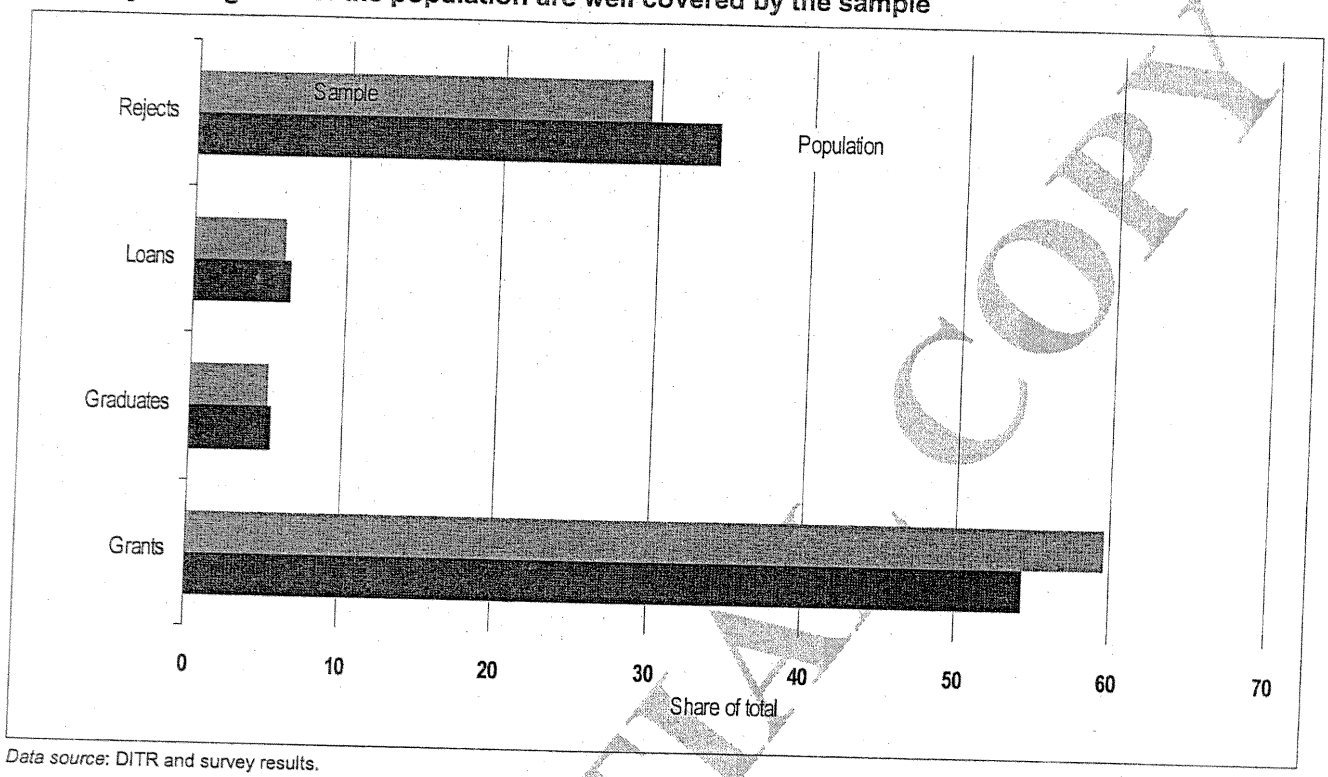
Although the non-recipient group is not a valid control group, we have collected a great deal of information about this group. This information may be of value in the future design of the scheme as it provides a profile of unsuccessful applicants and, at least to some extent, what they went on to do in the absence of Start funding.

C.2 Major sector shares of the population are well covered by the sample



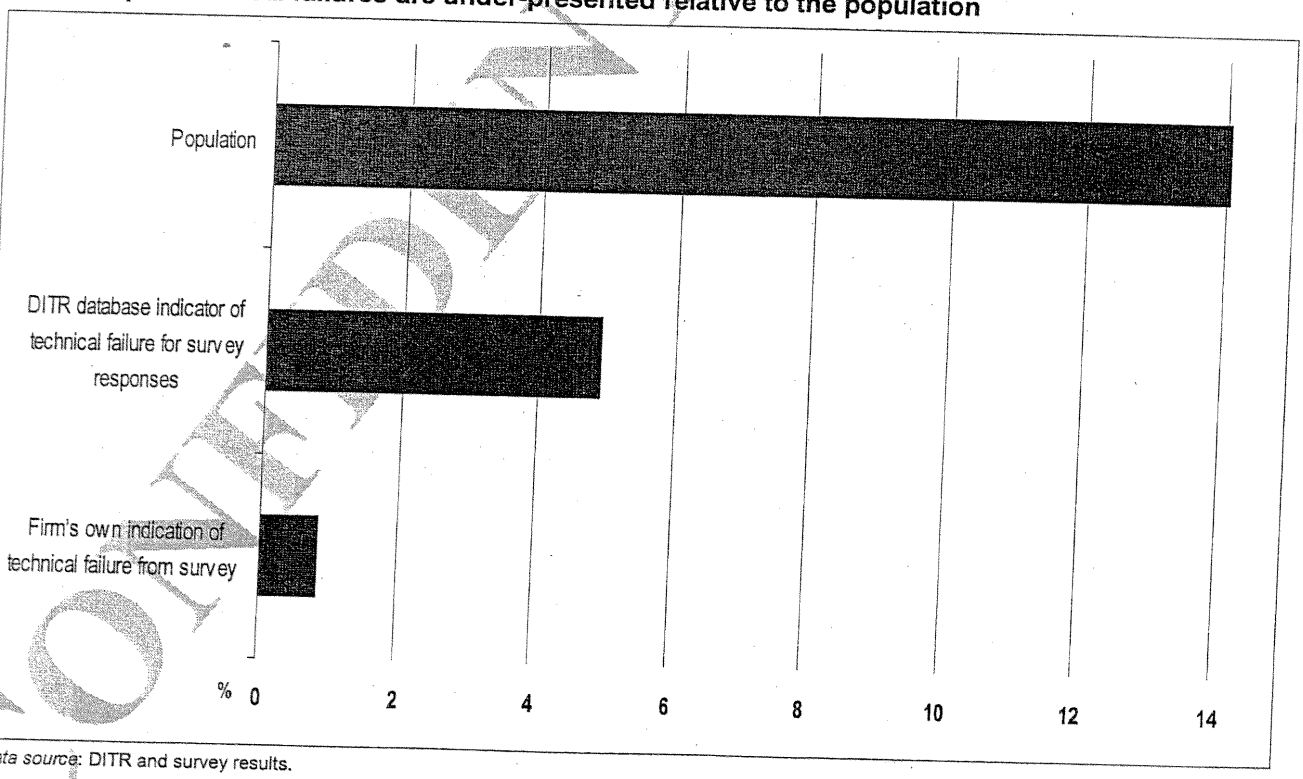
Data source: DITR and survey results.

C.3 Major categories of the population are well covered by the sample



Data source: DITR and survey results.

C.4 Sample technical failures are under-presented relative to the population



Data source: DITR and survey results.

C.5 Reasons to reject the control group

First reviewer

An optimal control sample for the review would enable one to make unbiased estimates about R&D outcomes in the population of businesses eligible to apply for R&D Start that have not participated in the program.

As there is no complete listing of this population, an incomplete list (sampling frame) must be used to draw the control sample. In order to make valid (unbiased) inferences/estimates in relation to a target population, the sampling frame for a survey must closely reflect the underlying population. If the coverage of a sampling frame has significant flaws or gaps, extrapolation from the results of the associated sample survey becomes subject to a significant risk of bias.

In our opinion, the sampling frame selected for the review (unsuccessful R&D Start applicants), while convenient and cost effective (as the Department has contact details), involves a high risk of bias. Unsuccessful applicants (excluding those who are rejected on the basis that their project does not meet the definition of R&D and those who are rejected because they are not non-tax exempt companies incorporated in Australia) form a small subset of businesses eligible to apply for R&D Start that have not participated in the program.

The risk of bias flows from the fact that this subset may differ in important respects from the broader set of eligible firms that have not participated. For example, unsuccessful applicants may have a lower (or higher) than average R&D execution capability.

An approach to control sample selection with a significantly lower risk of bias would involve using a broader sampling frame (for example, lists of members of industry associations or commercial business listings). This approach would, however, involve a higher cost (due to the need to filter out ineligible firms).

To maximise the analytical value of the control group design, a degree of stratification in sample selection would also appear to be warranted (for example, by industry and turnover).

In conducting a cost–benefit analysis of the R&D Start program, a key cost category to assess is the compliance/application costs incurred by all applicants (successful and unsuccessful). The results of the survey of unsuccessful applicants can validly inform this assessment.

We would have reservations about using the data collected from the survey of unsuccessful applicants for other elements of the cost–benefit analysis, because of the high risk of bias outlined above. The risk of bias flows from the fact that this subset may differ in important respects from the broader set of eligible firms that have not participated. For example, unsuccessful applicants may have a lower (or higher) than average R&D execution capability.

Continued on next page

Indicators of disaggregated benefits and costs

Statistically, we were unable to find any difference in the R&D performance of the various elements of the Start program. Although charts C.6 and C.7 show differences in the benefit to cost ratios and knowledge economy spillovers of the elements, the differences are not statistically different. Although the means are different and follow an expected pattern, the relatively high standard errors give us no assurance that the differences are statistically different.

C.5 **Reasons to reject the control group** (continued)

Second reviewer

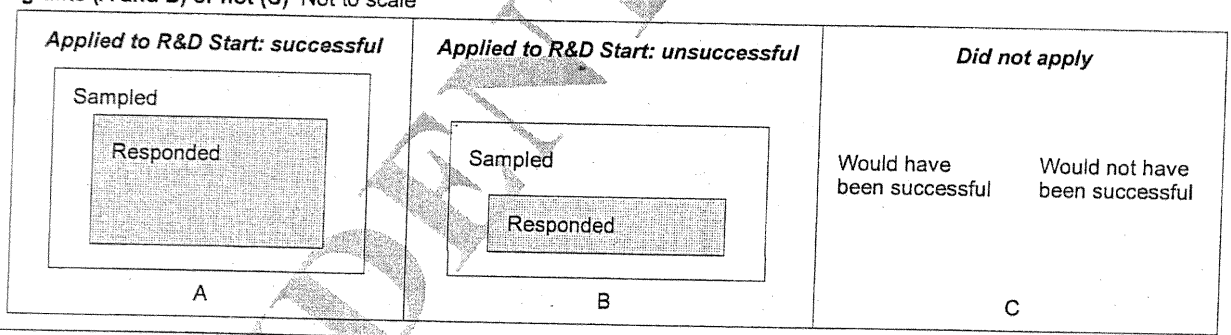
By limiting the sampling frame for the control group to unsuccessful applicants, there is a mismatch between the objective and the target population. This will result in a bias if there are major differences in the outcomes between the R&D subsequently performed by these unsuccessful applicant companies and R&D conducted by companies that did not apply for R&D Start grants. This is shown diagrammatically in the table below, which classifies companies according to whether they applied to R&D Start and were successful or not. Biases could arise from differences between the types of companies represented in sections B (unsuccessful applicants) and C (did not apply). Important potential differences include the size and resources of these companies and in the types of projects that are undertaken (size, riskiness of the project). The degree of potential bias is hard to estimate without further information on the reasons that companies in section C did not apply for grants. There could be many reasons:

- already had adequate funding either internally or from other non-government or semi-government sources
- thought they would be unsuccessful
- not aware of the program.

Each would have to be assessed in relation to whether that information would be associated with the primary data used in the cost-benefit analysis.

Another problem with the current control group is that it appears to contain projects which are outside the scope of the program (that is, projects that are not defined as R&D). The data from these should be excluded from the analysis.

Hypothetical division of companies undertaking research and development into those applying for R&D grants (A and B) or not (C) Not to scale



Moreover, we are unable to detect any statistically significant relationship between benefits and costs and:

- knowledge spillovers
- size of firm in terms of turnover
- collaboration.

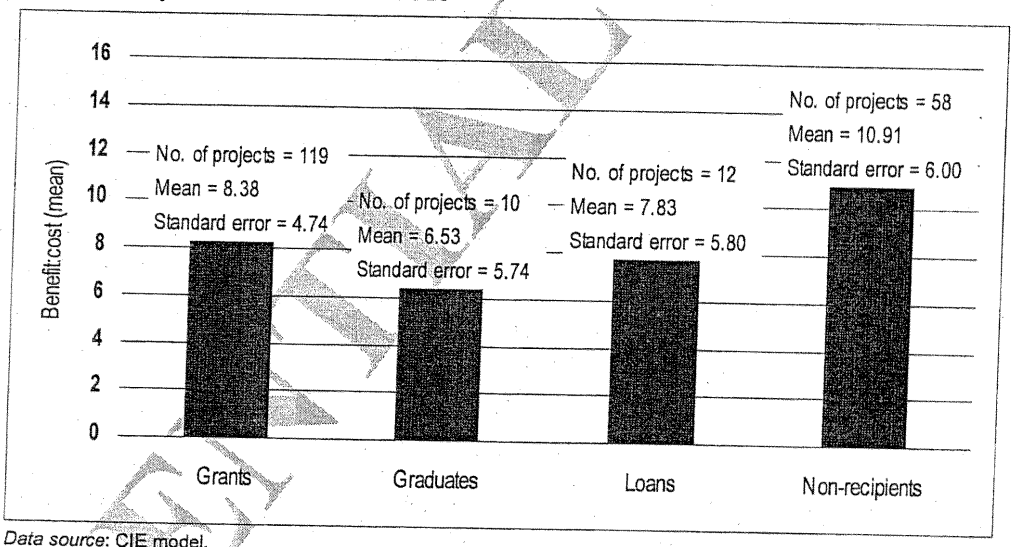
These results are not surprising.

- There is considerable luck and uncertainty affecting R&D results, so it is not surprising that there is any obvious relationship between size of firm and benefits and costs.

- Collaboration is something that firms are more likely to seek if they have a problem in developing their R&D and, in helping overcome problems, on average collaboration helps these firms achieve the same results as firms able to solve their own problems.

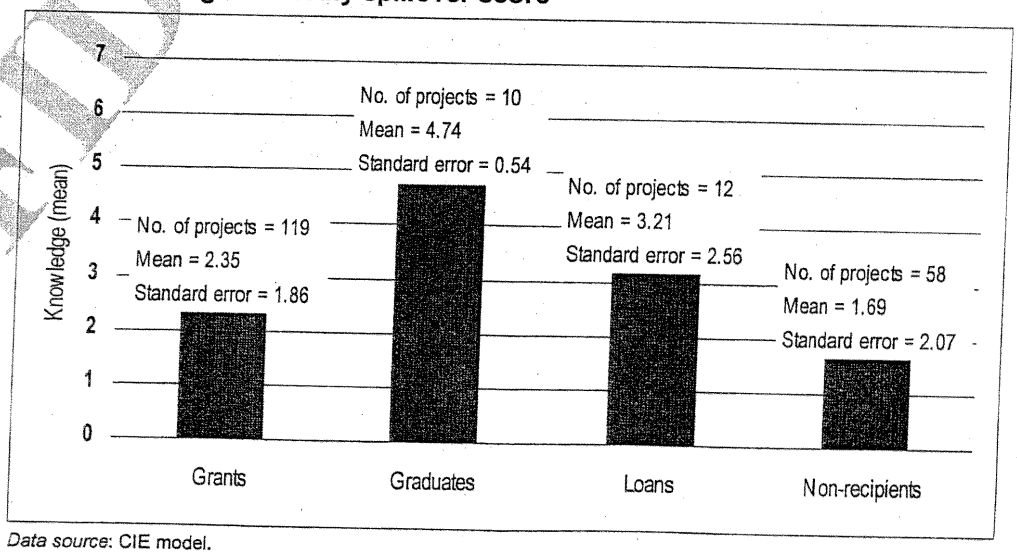
The only statistically significant difference we are able to detect is between firms whose R&D develops a platform technology that benefits other firms and the expected benefit to cost ratio. The differences in the relative performance of the two groups supports the idea that it may be more difficult to capture the gains from R&D that develops general platform technologies than it is for more specific technologies developed for target markets. However, quantitatively the significance of this is small.

C.6 **Mean perceived benefit–cost**



Data source: CIE model.

C.7 **Knowledge economy spillover score**



Data source: CIE model.

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