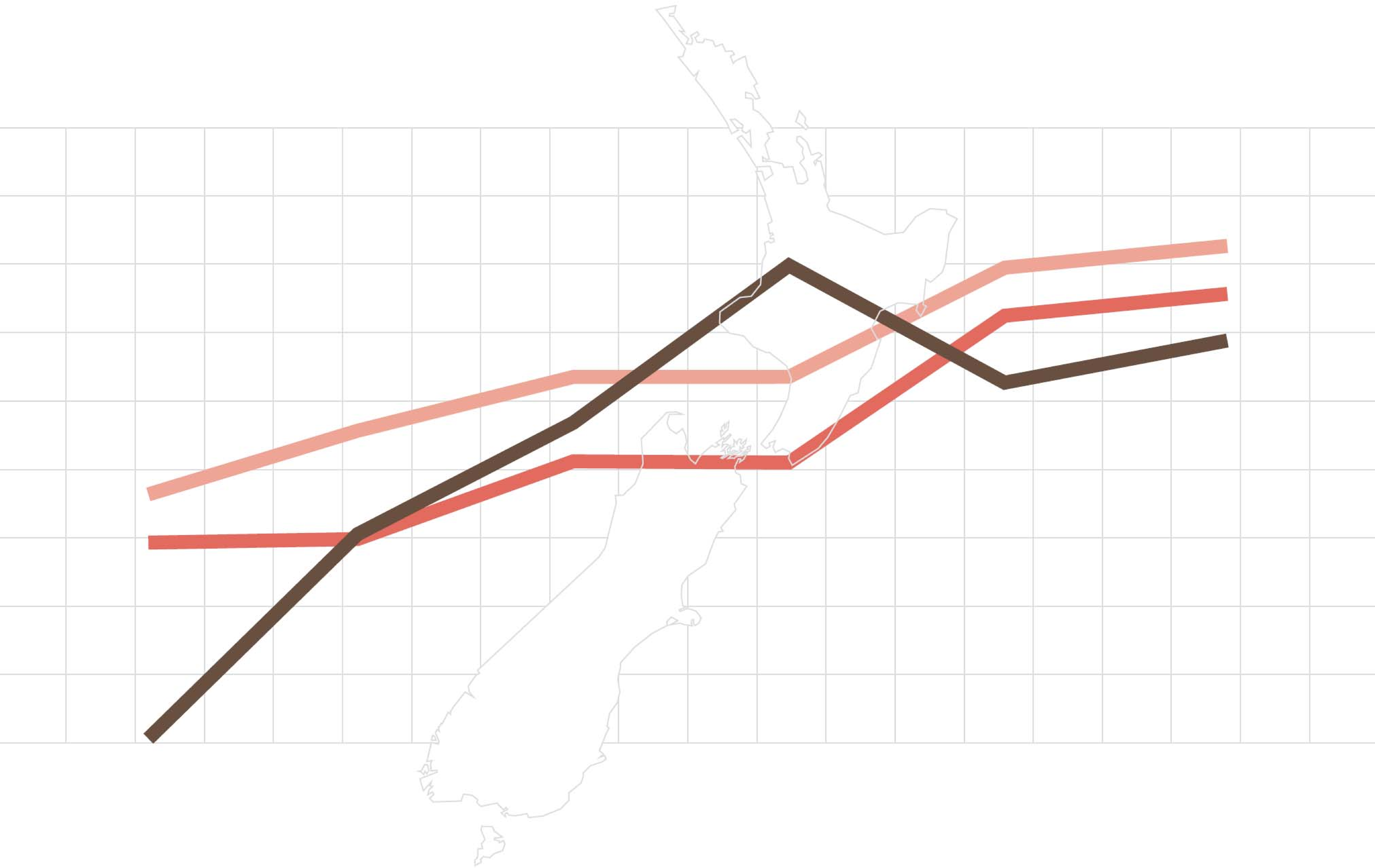
MINISTRY OF RESEARCH SCIENCE + TECHNOLOGY

TE MANATŪ PŪTAIAO



RESEARCH AND DEVELOPMENT IN NEW ZEALAND

A DECADE IN REVIEW

The commentary and analysis of this report is provided by the Ministry of Research, Science and Technology (MoRST).

This report uses research and development survey data, jointly collected by MoRST and Statistics New Zealand. Access to the survey data used in this study was provided by Statistics New Zealand under conditions designed to give effect to the security provisions of the Statistics Act 1975.

Full tables, methodology and this report are available at
www.morst.govt.nz

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FOREWORD

As we constantly strive to improve the quality and impact of our science, we need to be able to look back and measure the results of our efforts. We need to understand that the impact of science is not seen after just one, two or three years. We must review our performance over the longer term to be able to identify trends and impacts.

Science and innovation can transform our lives and create value for us all. Research and development (R&D) is key if we are to achieve economic transformation, a strong national identity and protect families, young and old. R&D will be the driver behind the creation of new, high value products and exports, it will help us protect our unique flora and fauna and ensure the health and wellbeing of New Zealanders.

For the first time, this report provides us with a longer term perspective of changes to the New Zealand science system. This report – *Research and Development in New Zealand – a Decade in Review* – is a useful and powerful tool for science managers, policy makers, politicians, researchers and educators. It is important that we continue to measure our successes and recognise where we can improve. It is only through the provision of data, such as that contained in this report, that we can reflect on our efforts.

The results show that over the past ten years, we have seen a 60 per cent increase in the number of scientific positions. The amount of R&D carried out in New Zealand has almost doubled and we have seen 11 per cent growth in business R&D per annum since 2000. These are exciting findings and are a testament to those working in labs, writing papers, submitting funding proposals and performing world class research, right here in New Zealand.

Steve Maharey
Minister of Research, Science and Technology
June 2006.

ACKNOWLEDGEMENTS

The concept of developing a longitudinal analysis of research and development (R&D) trends spanning a ten year period was first mooted in October 2004. Several methodological changes to the way in which R&D data have been collected over the years, resulted in non-comparable data. This posed problems for policy agencies in terms of measuring the growth of R&D over longer periods.

At the heart of this report is the ability to analyse comparable data sets over time. Our thanks to Mr Bill Pattinson, a statistical consultant based in Canberra. Bill developed the comparability bridging methodology and contributed to the report content. The report has greatly benefited from Bill's experience running R&D surveys in Australia for over 20 years and from his work revising the OECD Frascati Manual.

Our thanks to Statistics New Zealand for their help and assistance in developing and reviewing 'The Decade in Review' and for providing the source R&D data, price deflators, census and migration data used in the report.

Our thanks to Statistics Canada for endorsing the methodology used in this report and their support of this project to develop comparable R&D statistics.

We would like to thank the New Zealand Vice-Chancellors' Committee (NZVCC), in particular Jonathan Hughes, for their support and assistance in developing the university chapter of this report. In conjunction with the NZVCC, historical R&D data has been improved to provide comparable trends for New Zealand universities.

Our thanks also to each of the eight universities who agreed to make their individual data available for this report.

We acknowledge the support of the Association of Crown Research Institutes (ACRI), particularly Anthony Scott, for reviewing the chapter on Crown Research Institute (CRI) R&D and assisting with obtaining consents from its members to publish their individual data.

Our thanks also go to each of the nine CRIs who agreed to make their individual data available for this report.

I would also like to acknowledge the support of the Foundation for Research, Science and Technology, Royal Society of New Zealand and the Health Research Council of New Zealand for contributing data and reviewing sections of the report.

Finally, I would like to acknowledge the contributions of the 10,660 respondents to the R&D survey over the past decade. Without your input we would not have been able to produce this report.

Andrew Calder
Director – Performance and Evaluation,
Ministry of Research, Science and Technology
June 2006.

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1 INTRODUCTION

Research, science and technology (RS&T) is important to New Zealand's quality of life and future prosperity. Research and science create new knowledge. It is the application of this, often through technology, that leads to innovation and the positive changes that are required for improving wellbeing and economic growth. RS&T supports such improvements through:

- generating new knowledge to improve our understanding of the world around us, in particular knowledge that is unique to New Zealand;
- creating new products, processes and services to improve productivity in existing businesses and create new industries that lead to sustainable economic growth and a better standard of living;
- developing and testing new ways of enhancing and protecting the environment;
- increasing our understanding of how society functions and how best to create healthy and sustainable communities;
- building our knowledge of the factors influencing health status and developing new medical therapies and health strategies;
- helping to understand and manage risks in areas like geological hazards, climate change and pest management; and
- adapting ideas from overseas to produce benefits for New Zealand.

The importance of RS&T in generating these improvements is increasing. Countries that have exploited technological advances perform better and are better able to take advantage of technological advances in the future.

On the world stage, New Zealand research and development (R&D) makes up only a small proportion of global R&D. However, our science is seen as high profile and high impact. New Zealand's science system is connected to the global science network. While this cannot replace our own research activity, this larger science system is an important source of new knowledge and technologies that we draw on and adapt for our own needs and benefits. Our science system plays an important role in helping New Zealand to access this knowledge through international science linkages and collaborations at country, regional or research institute level.

THE MEASUREMENT OF RESEARCH AND DEVELOPMENT

[1] OECD, 2002. *Frascati Manual: Proposed standard practice for surveys on research and experimental development.* This manual provides standard definitions relating to collection of R&D data through surveys, and is used throughout OECD member countries.

The measurement of R&D is defined by the Organisation for Economic Co-operation and Development (OECD) in the Frascati Manual[1] as:

> *'creative work undertaken on a systematic basis in order to increase the stock of knowledge. It is characterised by originality, where investigation is a primary objective'.*

Research and development encompasses basic or untargeted research, as well as research supporting identified sectors and needs (sometimes called strategic research). Operational research and routine data collection and monitoring activities are excluded from the OECD definition of R&D, although they are recognised as important activities of the science system that often provide input to research. In many cases routine monitoring datasets are subsequently used for R&D purposes, and so a rather grey area in the measurement of R&D exists. Some types of research, such as market research, are outside the scope of OECD R&D and therefore are outside the context of this report. (See Appendix.)

Internationally, the measurement of R&D began in 1963 with the development of internationally agreed definitions for the measurement of R&D.

The measurement of R&D commenced in New Zealand in 1990. Although R&D activities were reported in an ad hoc manner prior to 1990, these reports were not consistent in their measurement of R&D. Research and development in New Zealand is now measured using a biennial survey, jointly conducted by Statistics New Zealand and the Ministry of Research, Science and Technology (MoRST).

PURPOSE OF THIS REPORT

The accurate and consistent recording of detailed R&D survey data (unit record files) began in 1994 and has continued until the present day. However, during this period, several methodological changes have resulted in non-comparable statistics. Changes to the methodology in recent years has resulted in very large reported increases in the amount of R&D performed in New Zealand – particularly in the private sector.

In response to a call from policy makers to provide a comparable time series of R&D in New Zealand, MoRST began work to develop a methodology that would enable real change across the time series to be measured.

The creation of a document detailing the changes in R&D in New Zealand from 1994 to 2004 has several purposes. The comparable measurement of R&D allows policy makers and the R&D sector to understand change within the system over the past 10 years.

This report provides comparable information for all sectors of the New Zealand science system, and provides detail not previously released in the biennial R&D publications. Specifically, business enterprise R&D is discussed in detail, with results for the primary, manufacturing, scientific research and other services industries shown separately over time. R&D performed by Crown Research Institutes (CRIs), which was previously reported as a part of government R&D, is also discussed in detail. In addition, we have individually identified the contributions made by each of the CRIs and universities.

THE NEW ZEALAND SCIENCE LANDSCAPE

The unique structure of our economy also influences government investment in RS&T. Important factors are the dominance of the primary sector, with its reliance on publicly funded research, together with a limited size and number of RS&T-intensive firms.

New Zealand's RS&T system can be described as the network of people and their organisations that carry out or manage science activities for New Zealand. Central to the system are New Zealand's scientists and researchers working in CRIs, universities, polytechnics, hospitals, local authorities, research associations and private firms.

A wide range of 'users' of science are connected into the RS&T system. For example, firms wanting to improve or develop new products or services, regional councils needing to understand and manage environmental resources or risks, or health agencies wanting to understand the determinants of disease in a New Zealand context. They will typically draw on both New Zealand and overseas science and research, and often work with scientists in determining science needs and opportunities.

The education system interlinks closely with the RS&T system. Secondary and tertiary education institutes, as well as CRIs and private firms, provide training for scientists as well as people going into other professions who may use science knowledge. The RS&T system is also part of New Zealand's broader society and linked to global networks of innovation and science.

CHANGES IN THE NEW ZEALAND SCIENCE SYSTEM

Our science system has evolved considerably over the past 20 years and now sits within a markedly different operating environment, with greater expectations and opportunities.

The period 1985 to 1995 was marked by institutional change – the Department of Scientific and Industrial Research (DSIR) and the research and advisory divisions of the Ministry of Agriculture (MAF) were disestablished, the separate policy and investment agencies were set up, and CRIs were established to align New Zealand's public science with its key sectors.

Between 1995 and 2005 whole-of-government growth and innovation policy initiatives were launched, as well as strategies in areas such as biosecurity, biodiversity and climate change.

NEW ZEALAND'S SCIENCE SYSTEM IS INTERNATIONALLY DISTINCTIVE

- The proportion of R&D that is funded by government (45 percent) is much higher than the OECD average (30 percent)*. A further seven percent is funded by universities through their own funds. The high contribution of public sector funding reflects the make up of New Zealand's industry sectors and our unique environment and its science needs.

- Our nine CRIs, constituted as limited liability companies, deliver national benefit science and research to their particular sectors.

- Our strengths in science and research are in the areas of biology, agriculture, horticulture, environmental science, earth science, materials science, health research and indigenous knowledge. There is a relative absence of large military defence, pharmaceutical and large-scale manufacturing research.

- We have robust research safety and ethical regulation, particularly in biological and human health research, which takes a broad account of the social, cultural and environmental context for research activity.

- There is separation of policy, purchase and provider roles in our science system, and predominance of grant-based output and outcome-focused contestable funding processes.

* OECD, MSTI 2005/2

THE KEY PLAYERS

Research and development in New Zealand is driven by a small number of organisations conducting large amounts of R&D.

1. CROWN RESEARCH INSTITUTES

CRIs were established in 1992 with the primary purpose of undertaking research for the benefit of New Zealand. In fulfilling this purpose CRIs are required by law to:

- undertake research for the benefit of New Zealand;
- pursue excellence in all their activities;
- comply with applicable ethical standards;
- promote and facilitate the application of results of research and technological developments;
- be a good employer and exhibit a sense of social responsibility; and
- operate in a financially responsible manner and maintain their financial viability.

2. TERTIARY EDUCATION INSTITUTIONS

Tertiary Education Institutions (TEIs) undertake a sizable proportion of New Zealand's RS&T activity. Universities perform by far the greatest share of R&D in this sector. Funding comes from both government RS&T and education funding as well as private sector sources. This investment provides for the development and maintenance of research capability in New Zealand and underpins the provision of quality tertiary education. The allocation of funds made through Vote Education is determined by the institutions themselves and as a result, the tertiary institutions, and the scientists they employ, play an important role in determining what RS&T is undertaken in New Zealand.

3. PRIVATE SECTOR

Private sector R&D in New Zealand (as elsewhere in the world) is dominated by 25 firms that contribute to over 50 percent of Business R&D[2]. Private sector R&D is somewhat polarised, with a group of older, well-established firms and a group of relatively young, small, high-tech firms.

[2] 2004.

4. RESEARCH ASSOCIATIONS

Research Association is a generic term for non-government research organisations.

There are two main types of research association. The first and largest are non-governmental, industry-linked research providers. They have capabilities in research and technology transfer, often referred to as extension in the primary sector, that individual companies may not be able to manage. They also carry out a range of research functions and have strong industry links. They receive funding from a number of sources, including industry levies mandated by legislation (which accounts for the bulk of the funding), commercial income and some Foundation for Research Science and Technology (FRST) income.

These organisations include the Building Research Association of New Zealand (BRANZ) (the Building Research Levy Act), Dexcel Limited (the Commodities Levy Act) and the Heavy Engineering Research Association (HERA) (the Heavy Engineering Research Levy Act).

The second type of research associations are private sector organisations that rely on funding from corporate, charitable and contestable government sources. They also focus on specific areas of expertise, such as medicine or particular science areas. They include organisations such as the Malaghan Institute and the Cawthron Institute.

5. LOCAL GOVERNMENT

Local government plays a significant role as an end-user of science, particularly in the area of environmental management. As New Zealand's primary environmental management agencies there is significant capability within regional councils for operational environmental science. However, this capability is not spread evenly over local government. Local government is a small but consistent funder of R&D that is primarily contracted to CRIs, universities and the private sector. Several larger regional councils also conduct some R&D focused on environmental management issues.

6. SCIENTIFIC SOCIETIES AND ASSOCIATIONS

New Zealand has around 60 scientific and technological societies that represent, coordinate and promote the advancement of science and research within mainly disciplinary groupings. These include the New Zealand Institute of Agricultural and Horticultural Science Inc, the New Zealand Institute of Chemistry, New Zealand Grasslands Association and the Nutrition Society of New Zealand. The Royal Society of New Zealand (RSNZ) helps coordinate and represent these societies. The New Zealand Association of Scientists is an independent association of scientists with membership across the sciences.

7. OTHER GOVERNMENT AGENCIES

A wide variety of other government agencies play differing roles within the RS&T system. These range from operational agencies, such as the New Zealand Police, purchasing technical services from research organisations through to the Department of Conservation (DOC) carrying out its own scientific research. Other agencies perform regulatory roles. For example, the Environmental Risk Management Authority (ERMA) decides applications to introduce hazardous substances or new organisms, including genetically modified organisms, while the Ministry of Economic Development (MED) regulates the intellectual property regime. Ethical advice and approvals are carried out by agencies such as the Animal Ethics Committee, administered through the Ministry of Agriculture and Forestry (MAF), and the Health Research Ethics Committee, administered by the Health Research Council (HRC).

A role that has become increasingly important in recent years has been the contribution of government departments to science and innovation policy on a whole-of-government basis, particularly through initiatives under the Growth and Innovation Framework (GIF). This has led to greater co-operation and collaboration among government agencies in the development of science and innovation policy.

AN OVERVIEW

INTRODUCTION

This chapter summarises the performance and funding of New Zealand R&D for the period 1994 to 2004. The data on which this summary has been prepared is shown in more detail in later chapters. It is important to recognise that the data used in this report has been compiled with the key objective of providing a series of data that is as consistent as possible over time. The data differs from that published in other MoRST, Statistics New Zealand and OECD publications containing R&D statistics, as that data has been compiled with a view to providing the best possible estimate of R&D at the time the surveys were undertaken. However, for international benchmarking purposes we have presented unadjusted figures in line with OECD publications.

THE KEY DIFFERENCES FROM THE DATA USED IN PREVIOUS REPORTS

- The data for the Business sector has been compiled so that it generally excludes the smallest businesses, with fewer than 10 employees.
- The data for the Business sector has been compiled as if the 2004 survey was conducted using a list-based approach (as in previous years) rather than the sampling approach based on the Statistics New Zealand Business Register.
- The data for the Government sector has been compiled in respect of CRIs only.
- The data for the Higher Education sector, which is based on universities only, has been recompiled for years prior to 2002 using the same methodology adopted in 2002 and 2004.

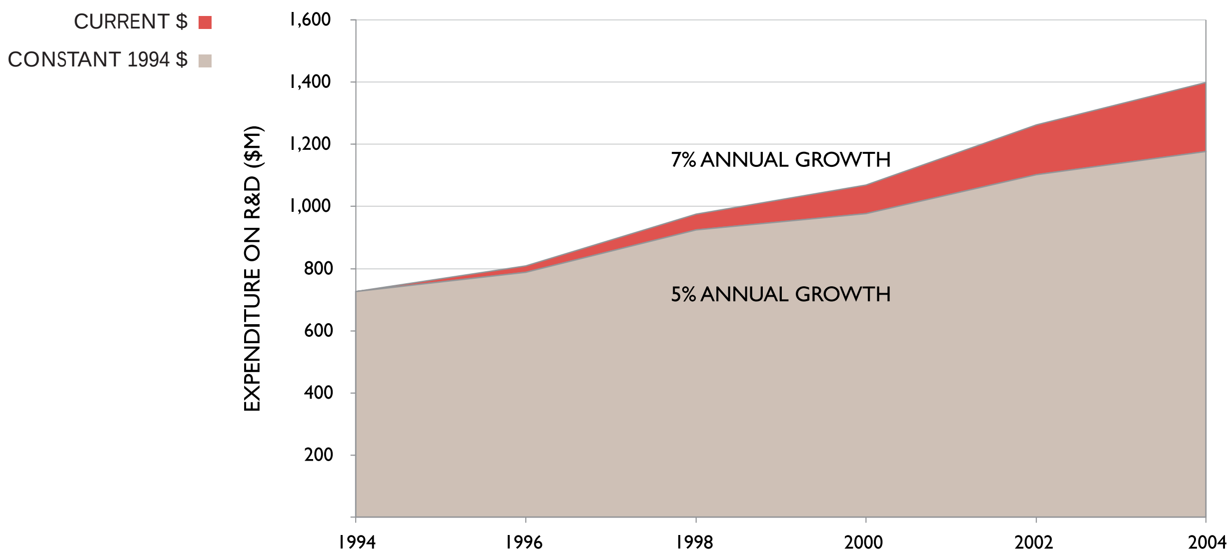
See the Appendix for an outline of the methodological basis for the results used in this report.

A more detailed methodology and statistical tables of the data presented in this report are available at www.morst.govt.nz

R&D EXPENDITURE IN NEW ZEALAND

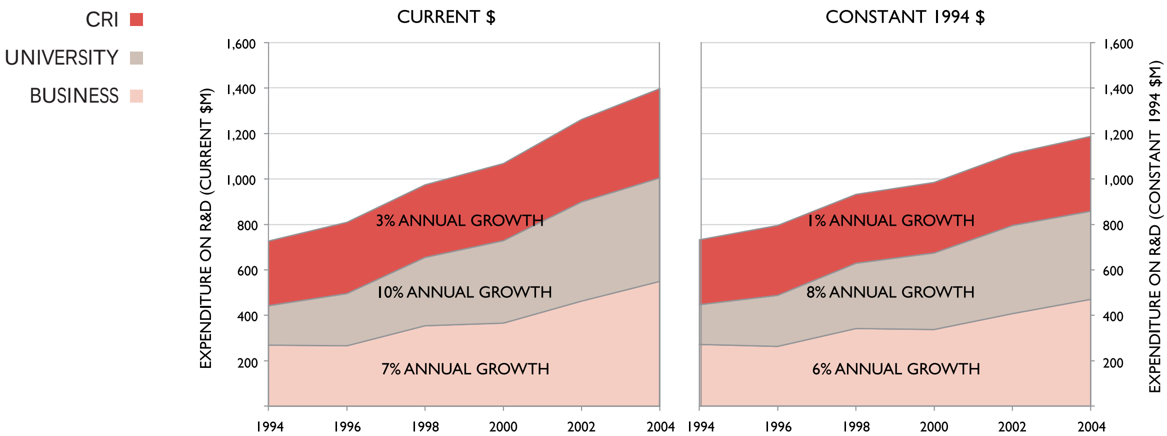
Chart 2.1 shows the value of R&D performed in New Zealand between 1994 and 2004. This shows us that over the period 1994 to 2004, New Zealand R&D has increased by 92 percent, which represents an average annual increase of seven percent. When one allows for price changes over the period, the growth in constant price terms is estimated to be 62 percent, representing an average annual increase of five percent.

CHART 2.1 TOTAL R&D EXPENDITURE, 1994–2004



As can be seen from Chart 2.2, each of the sectors has grown throughout the decade, although the University and Business sectors have contributed more to overall R&D growth than the CRIs. Overall total growth in New Zealand R&D appears to have been fairly consistent over the decade (five percent average annual growth). Growth appears to have accelerated since about 2000 in the Business sector, while the CRI and University sectors have grown at a more moderate, but consistent, pace.

CHART 2.2 R&D EXPENDITURE, BY SECTOR, 1994–2004



The effect of each of the sectors can be estimated by comparing their contributions with growth as shown in Table 2.1. As this shows, the Business sector was responsible for 42 percent of the growth in current price R&D over the period, the University sector contributed 42 percent and the CRI sector the remaining 16 percent.

TABLE 2.1 CONTRIBUTION TO GROWTH IN R&D EXPENDITURE, BY SECTOR, 1994–2004

SECTOR	Growth over decade ($M)	Growth over decade (%)	Contribution to total growth (%)
Business	280.7	104	42
University	281.2	162	42
CRI	110.0	39	16
TOTAL NZ	671.9	90	100

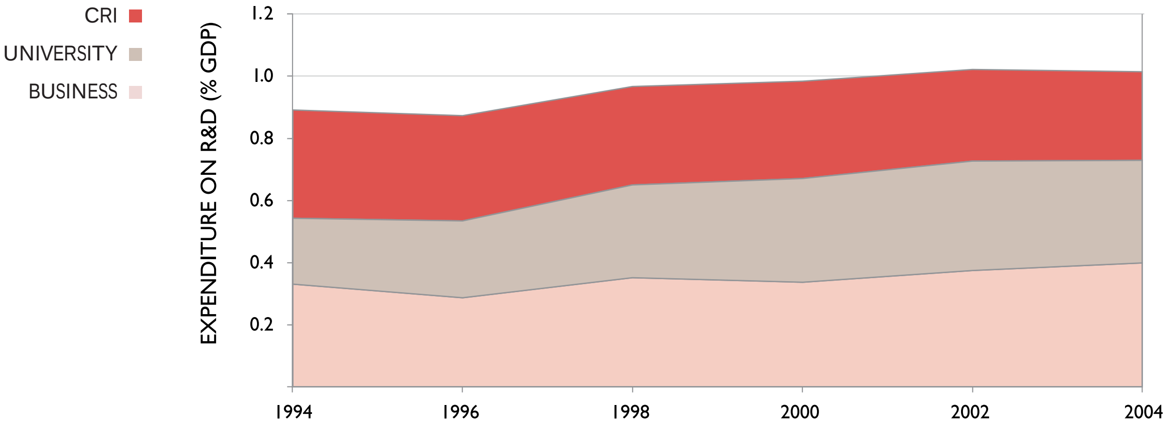
The figures quoted above are based on contributions to growth in current price R&D expenditure. A similar analysis based on the constant price series leads to very similar conclusions – the Business and University sectors have contributed a little more towards the growth (44 and 47 percent respectively) and the CRI sector contribution has been a little less (10 percent).

R&D AS A SHARE OF GDP

A standard way of analysing R&D performance within a country is to map its relationship with the gross domestic product (GDP) of the country. Analysing the data in this way for New Zealand shows that the ratio of R&D to GDP has increased from 0.95 to 1.05 percent over the 1994 to 2004 period. This represents an improvement of some 11 percent. However, even at this level, New Zealand is well below the OECD average and would need to more than double its R&D performance to reach the OECD average. More international comparative figures are shown in Charts 2.4 and 2.5.

As well as measuring the growth in New Zealand R&D, the data compiled for this analysis has enabled us to measure the growth for each of the performing sectors. Chart 2.3 shows the proportion of R&D expenditure to GDP in New Zealand from 1994 to 2004, for each of the performing sectors, and emphasises the contribution of each sector to the total New Zealand R&D effort.

CHART 2.3 R&D EXPENDITURE AS A PERCENTAGE OF GDP, BY SECTOR, 1994–2004



NEW ZEALAND COMPARED WITH ITS REFERENCE COUNTRIES

Chart 2.4 shows the proportion of R&D expenditure to GDP for New Zealand and its standard reference countries[1] over the past decade. This shows that New Zealand's level of R&D is well below that of the other reference countries and the OECD average. In 2004, New Zealand spent only slightly over one percent of its GDP on R&D, a figure that is well below most other countries. For New Zealand to reach this average it would have needed to lift its R&D performance in 2004 by about $1,400 million.

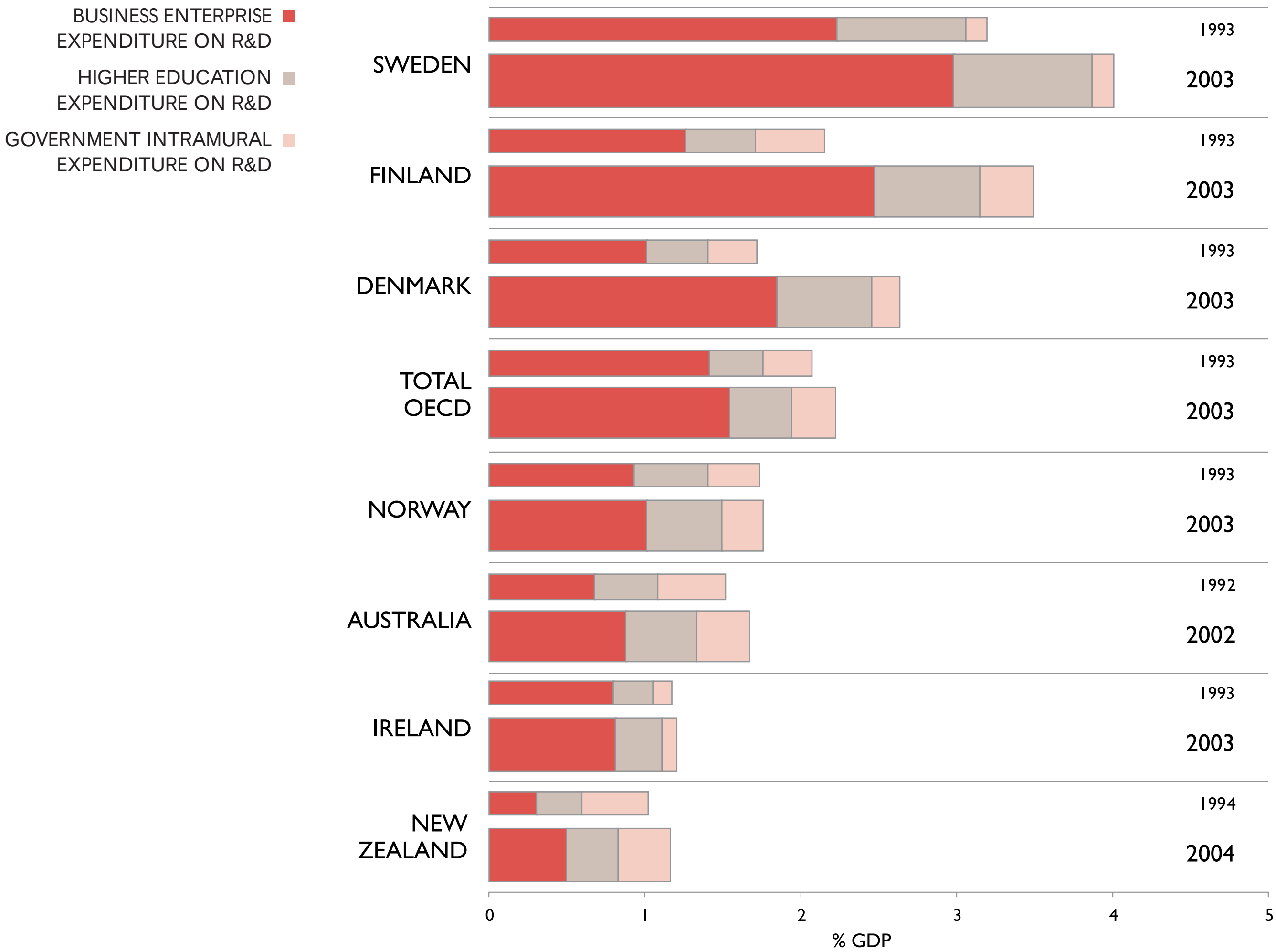
[1] Australia, Denmark, Finland, Ireland, Norway and Sweden.

The chart shows that the proportion of Government R&D (primarily performed by CRIs) and Higher Education R&D (primarily performed by universities) is relatively consistent with the OECD average and the other reference countries. However, the level of Business R&D is significantly lower than all of the other reference countries and has shown less growth than most of the other reference countries.

CHART 2.4

R&D EXPENDITURE AS A PERCENTAGE OF GDP – NEW ZEALAND AND REFERENCE COUNTRIES, 1994–2004

SOURCE: OECD MSTI 2005/2



NOTES: New Zealand 1994 and 2004 values are comparable with 1993 and 2003 values for other countries due to an overlap in reporting periods. Data is not available for Australia for 1993 and 2003.

New Zealand businesses perform only very small amounts of R&D compared with the reference group countries. The New Zealand 2004 ratio is only about one-third of the OECD average, and well below its reference group countries. For the New Zealand Business sector to reach the OECD average in 2004, it would have had to spend a further $1,430 million on R&D (tripling expenditure).

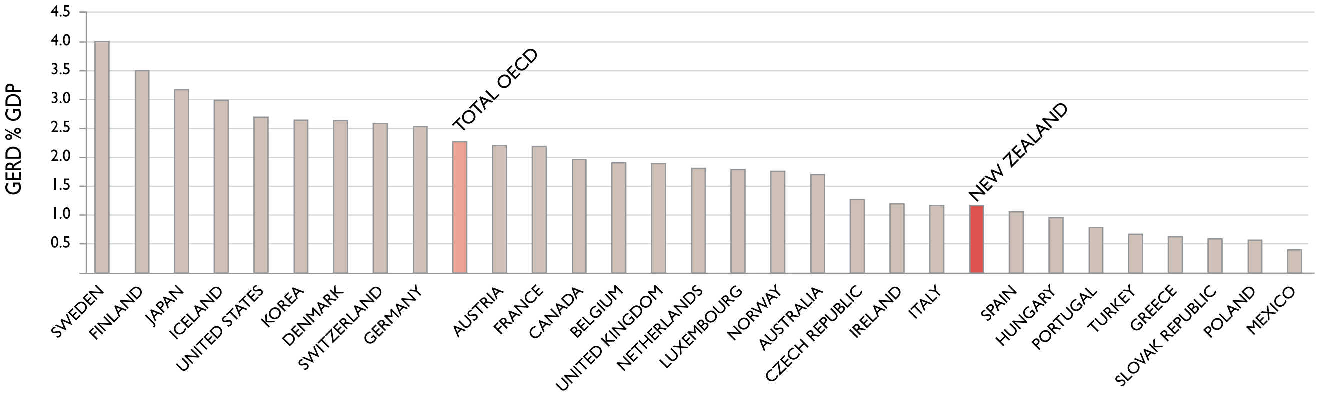
Higher Education R&D in New Zealand is still below the OECD average and most of its reference countries, but the difference is not as marked as for the Business sector. For New Zealand to reach the OECD average in 2004, it would have only needed to spend an additional $76 million on R&D. This additional amount is equivalent to 17 percent of the overall New Zealand R&D effort in the University sector.

In this comparison, the New Zealand Government sector has a ratio slightly larger than the OECD average, and is comparable with many other OECD member countries, excluding Iceland, which has a ratio more than twice as large as any other country (see Chart 2.5).

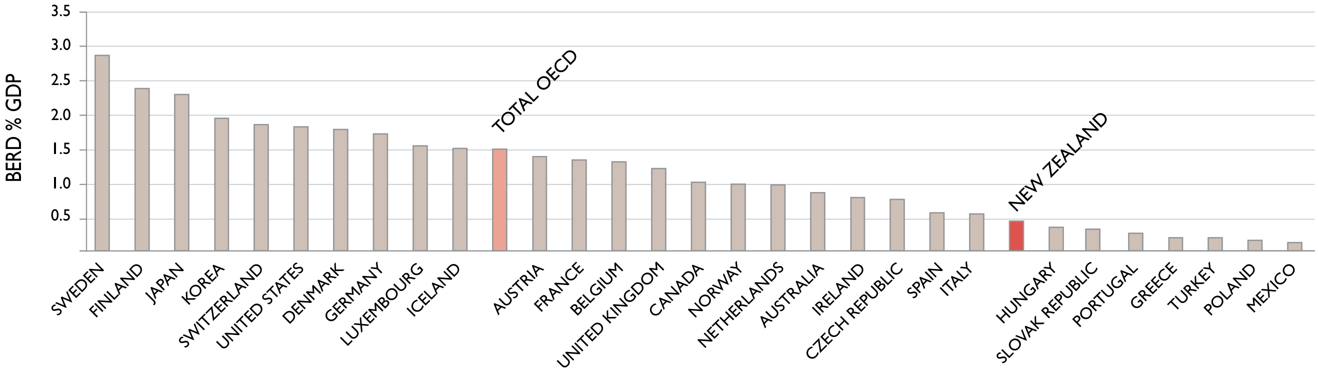
CHART 2.5 NEW ZEALAND COMPARED WITH OTHER OECD COUNTRIES, 2004 OR MOST RECENT YEAR

SOURCE: OECD MSTI 2005/2, using 2003 data, comparable with New Zealand R&D Survey 2004.

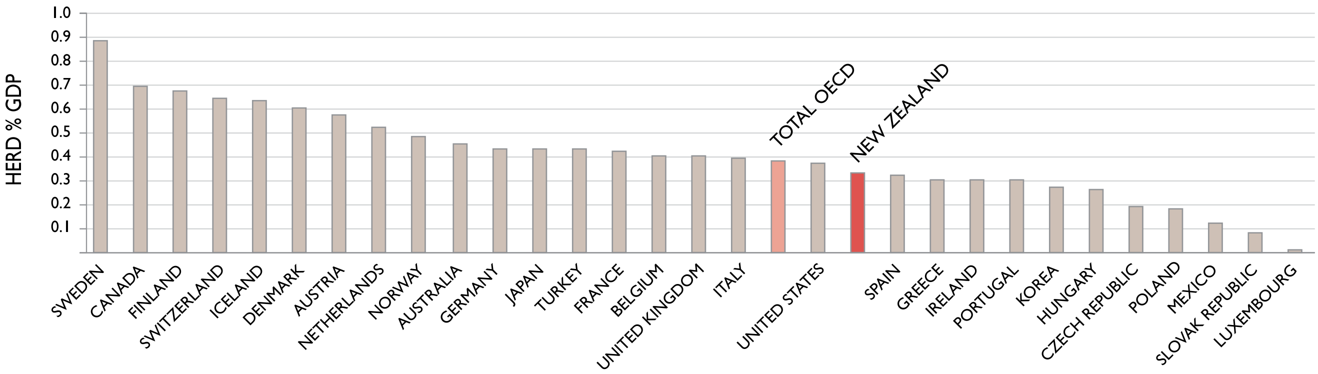
A) GROSS EXPENDITURE ON R&D



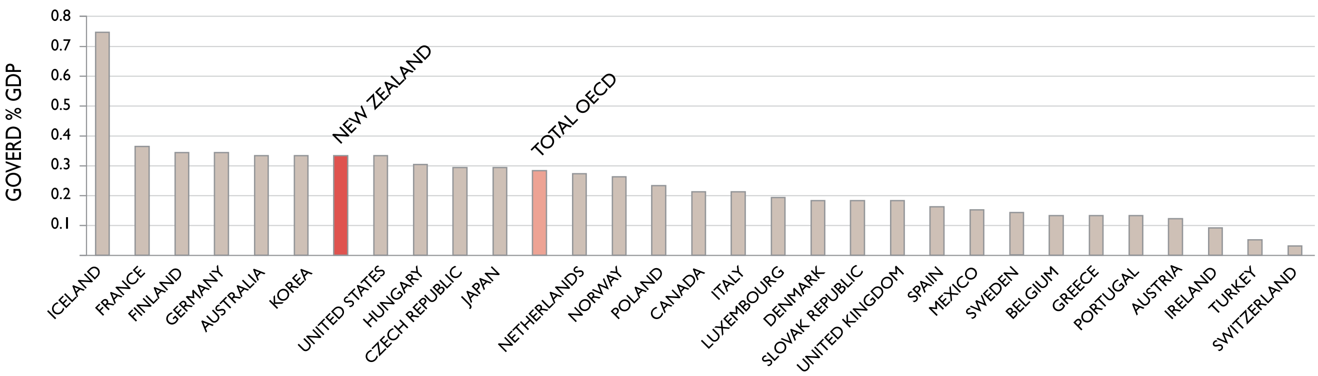
B) BUSINESS EXPENDITURE ON R&D



C) HIGHER EDUCATION EXPENDITURE ON R&D



D) GOVERNMENT EXPENDITURE ON R&D

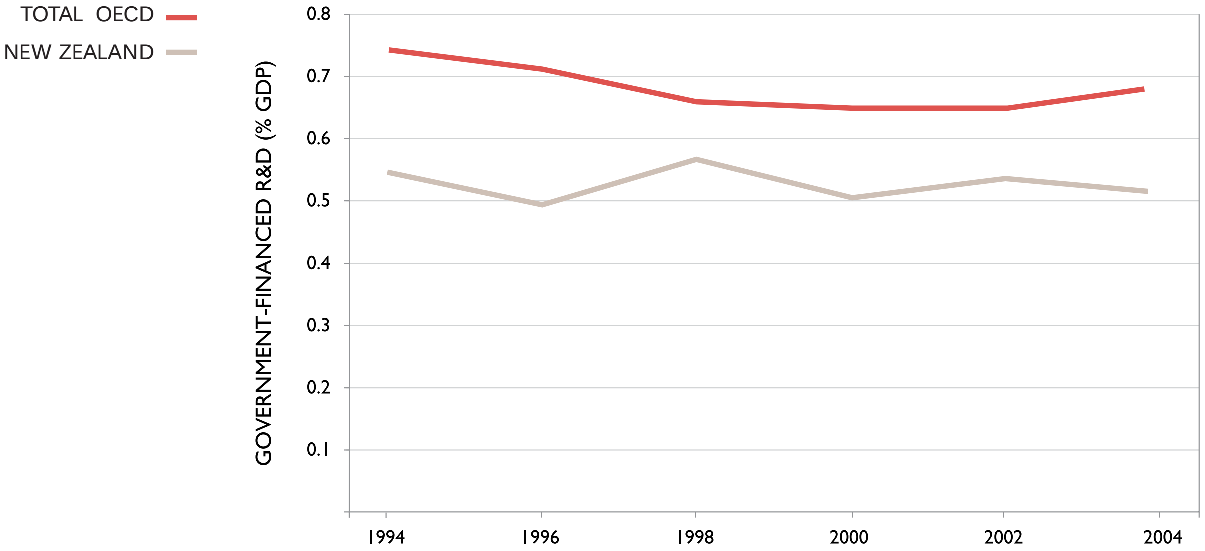


GOVERNMENT FINANCING OF R&D IN NEW ZEALAND

Government financing of R&D, measured as a share of GDP, is an important international benchmarking measure. This measure is reported regularly by all countries in the OECD. In 2004 Government financing of R&D in New Zealand amounted to 0.52 percent of GDP. Chart 2.6 below shows the trend in Government-financing of R&D over the last decade, together the total (average) for all OECD countries. The share for New Zealand has remained relatively constant over the past decade. The OECD total value has dropped somewhat over the decade and is currently 0.68 percent. However, it should be noted that for New Zealand, these ratios are heavily influenced by fluctuations in GDP.

CHART 2.6 GOVERNMENT-FINANCED R&D AS A SHARE OF GDP, COMPARED TO THE OECD AVERAGE, 1994–2004

SOURCE: OECD MSTI 2005/2



INTERNATIONAL BENCHMARKING

Should we really expect New Zealand to be at the OECD average for R&D performance?

There are a number of factors that mean New Zealand could be expected to spend less on R&D than the OECD average. Some of these are:

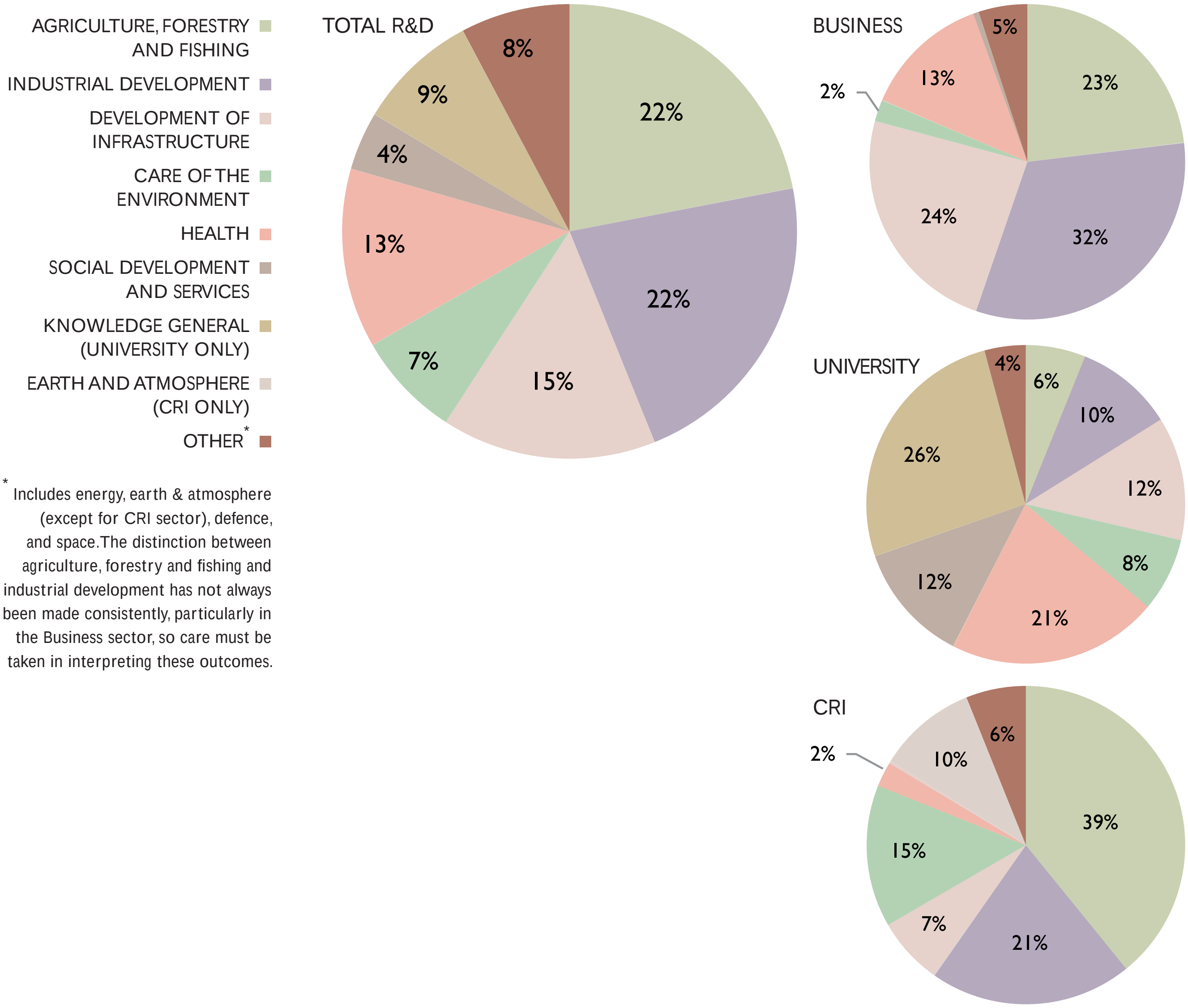
- New Zealand is a very small country in terms of its population and GDP.
- New Zealand has only a small number of large private sector firms. Experience shows that it is the largest firms (100+ employees) that are most likely to perform R&D and contribute the greatest proportion of business R&D.
- The industrial structure in New Zealand is such that industries that perform a lot of R&D in other countries are much smaller in New Zealand.
- The CRIs and universities conduct some research on behalf of business because they have the skills and infrastructure.
- Many multinationals operating in New Zealand do not need to perform large amounts of R&D in New Zealand as the R&D is already performed in other parts of the world.
- Much of New Zealand's R&D is based on primary production, which tends to cost less than other types of R&D, such as aerospace, defence or automotive R&D.
- New Zealand does not undertake defence, aerospace or automotive R&D, which in other countries contributes significantly to total R&D expenditure.

PURPOSE OF RESEARCH

R&D can be classified in a number of ways. The two most common ways in which R&D surveys describe the research being undertaken is by type of research and socio-economic objective, or the purpose of research.

CHART 2.7

SOCIO-ECONOMIC OBJECTIVE OF R&D IN NEW ZEALAND BY SECTOR, 2004



* Includes energy, earth & atmosphere (except for CRI sector), defence, and space. The distinction between agriculture, forestry and fishing and industrial development has not always been made consistently, particularly in the Business sector, so care must be taken in interpreting these outcomes.

When the socio-economic objective of R&D in each sector is compared (Chart 2.7), clear differences are seen. **Agriculture**, **forestry and fishing** and **industrial development** are very important to both the Business sector and the CRIs. **Development of infrastructure** is also prominent in the Business sector, whilst **care of the environment** is prominent amongst CRIs. **Knowledge general** is the most important outcome of University sector R&D. **Health** R&D is conducted primarily within the University and Business sectors.

SOCIO-ECONOMIC OBJECTIVE CLASSIFICATION

The broad socio-economic objective groupings used in this report are formed by grouping together the following detailed objectives:

AGRICULTURE, FORESTRY, AND FISHING
- animal production;
- dairy production;
- horticultural, arable production;
- forestry; and
- fishing.

INDUSTRIAL DEVELOPMENT
- meat and fish processing;
- dairy processing;
- fruit, crop and beverage processing;
- fibre and skin;
- wood and paper products; and
- materials, construction, electronics and engineering.

DEVELOPMENT OF INFRASTRUCTURE
- commercial and trade services;
- urban and rural planning;
- transport; and
- information, communication, and technology software.

CARE OF THE ENVIRONMENT

HEALTH

SOCIAL DEVELOPMENT AND SERVICES

KNOWLEDGE GENERAL
(university sector only)

OTHER
- energy;
- earth and atmosphere (reported separately for CRI sector);
- defence;
- space; and
- other.

TYPE OF RESEARCH

As shown in Chart 2.8, each sector performs a different mix of research types. The Business sector performs primarily **experimental and applied R&D**, with an emphasis on **experimental**. CRIs perform mainly **targeted basic** and **applied** R&D and universities perform near equal amounts of **pure basic, targeted basic and applied R&D**. Very little **experimental** R&D is performed by CRIs and, especially, universities.

CHART 2.8 TYPE OF RESEARCH IN NEW ZEALAND, BY SECTOR, 2004

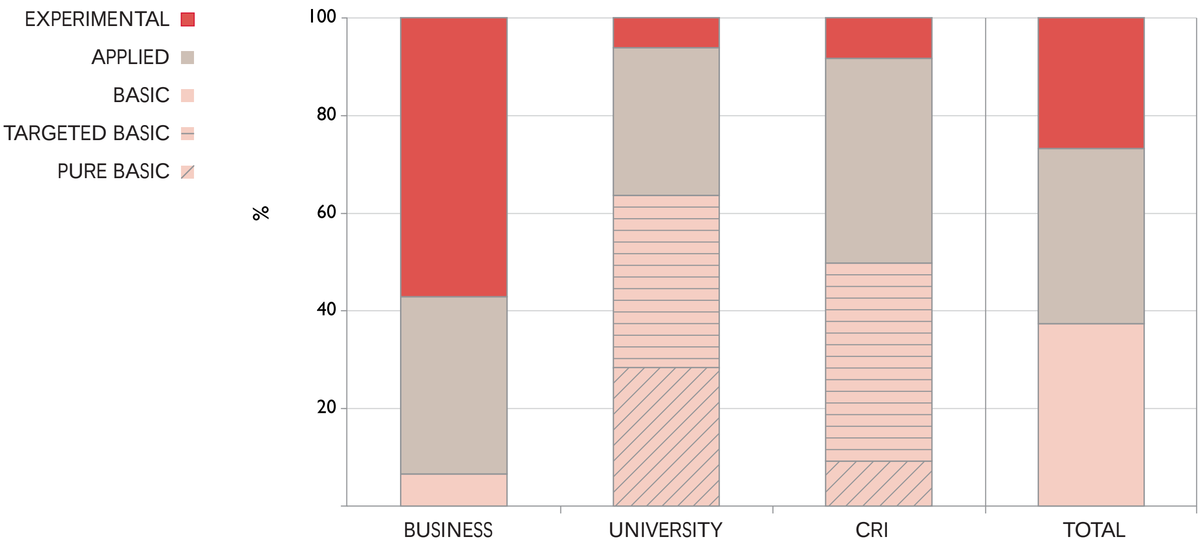


TABLE 2.2 TYPE OF RESEARCH IN NEW ZEALAND, 2004

TYPE OF RESEARCH	R&D expenditure 2004 ($M)	R&D expenditure 2004 (%)
Basic	521.4	37
Applied	501.9	36
Experimental	375.0	27

SOURCE OF FUNDS

R&D surveys measure R&D expenditure in two ways. The most often quoted way is in terms of how much R&D is performed. However, the surveys also collect information about the source of the money to pay for this research. The surveys measure whether the R&D performed has been financed from within the organisation itself, or from government, other businesses, tertiary institutes, overseas, or other sources.

The R&D performed in the Business sector is primarily funded from **own funds**, and contrasts strongly with the University sector and CRIs where **government** is the primary source of funds. Compared with CRIs, Universities fund more R&D by **own funds**, whilst CRIs fund comparatively high amounts from the Business sector. The Business sector funds proportionately more R&D from **overseas** funds than other sectors.

CHART 2.9 SOURCE OF FUNDS FOR R&D IN NEW ZEALAND, BY SECTOR, 2004

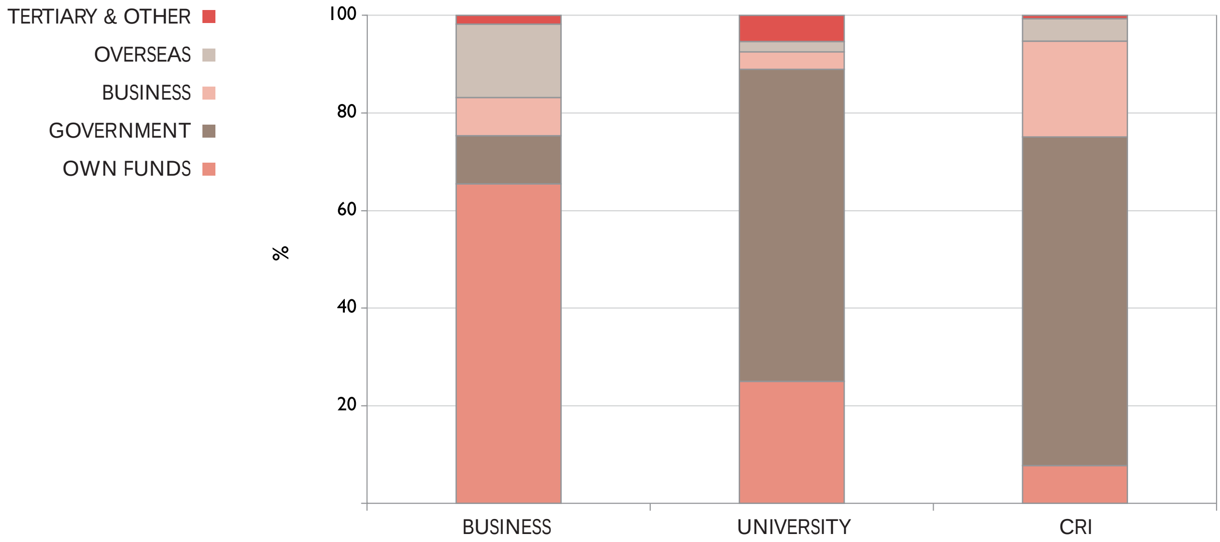


TABLE 2.3 GROWTH IN SOURCE OF FUNDS FOR R&D IN NEW ZEALAND, 1994–2004

SECTOR	Growth over decade ($M)	Growth over decade (%)	Contribution to total growth (%)
Government	280.1	78	42
Business	202.0	69	30
Tertiary	87.1	244	13
Overseas	91.7	477	14
Other	11.0	66	2
Total NZ	671.9	92	100

TYPE OF RESEARCH

In New Zealand R&D surveys, three different types of research are identified:

- BASIC RESEARCH: experimental or theoretical work undertaken to acquire new knowledge with either a broad underpinning reference to a likely application or with no particular application in view. This type can be further divided into:
  - pure basic research: experimental or theoretical work undertaken primarily to acquire new knowledge without any particular application in view; and
  - targeted basic research: experimental or theoretical work undertaken to produce a broad base of new knowledge likely to underpin solutions to current or future applications;

- APPLIED RESEARCH: original investigative research directed primarily towards a specific objective, to determine possible uses of basic research or to determine new ways of achieving a pre-determined objective; and

- EXPERIMENTAL DEVELOPMENT: systematic work that draws on knowledge gained from research and practical experience directed towards the creation of new materials, products or services.

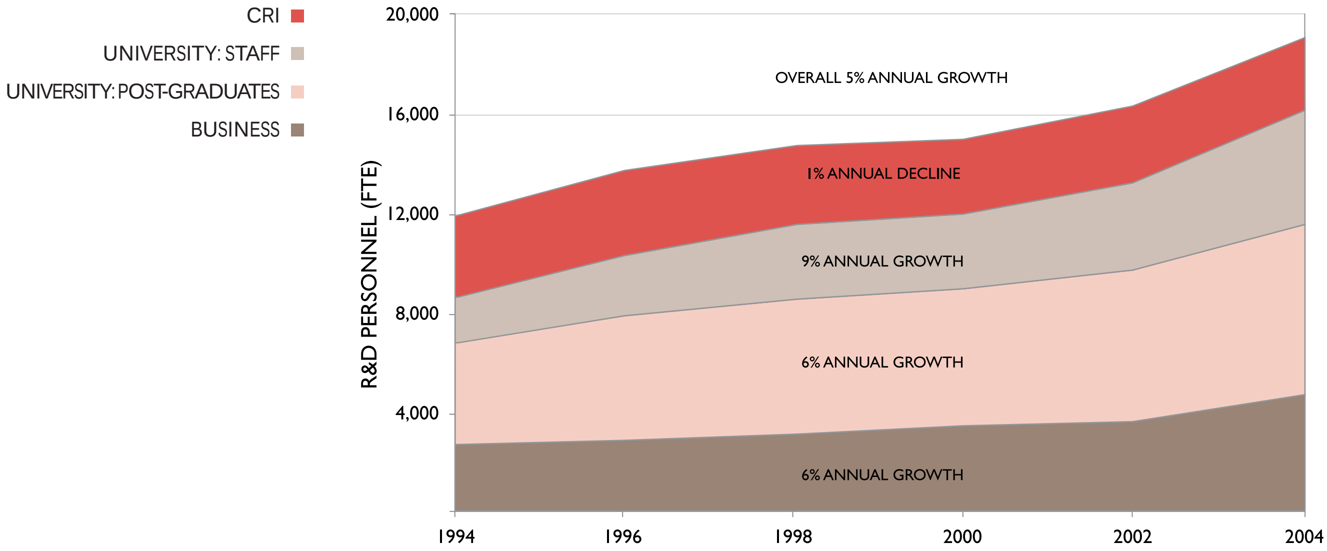
This classification implies a sequencing of research which may not exist in practice. Some research projects may involve a mixture of the various types of research. Hence the attribution to different types is somewhat problematic and should be treated with a certain degree of care by R&D analysts.

HUMAN RESOURCE INPUT INTO R&D

Chart 2.10 shows the full-time equivalent effort being made on R&D in New Zealand from 1994 to 2004. Over the period, the human resource inputs to R&D have grown by 60 percent, which is the equivalent of an average annual growth rate of five percent. The growth pattern seems to have been fairly consistent in the earlier and later years of the decade, but growth tailed off a little through 1998 and 2000.

The chart also shows the human resource input into R&D in each of the sectors identified earlier. For purposes of analysis, the growth in research by post-graduate students is shown separately from other R&D performed in the University sector. The growth rate appears to have been largely driven by the University sector, although the Business sector has also contributed in more recent years. In 2004, the University sector provided about 60 percent of the full-time equivalent human resource input into R&D in New Zealand.

CHART 2.10 HUMAN RESOURCE INPUT INTO R&D, BY SECTOR, 1994–2004



The effect of each of the sectors is shown in Table 2.4. The University sector input grew by 95 percent over the period, with the post-graduate effort increasing by 71 percent and the university staff effort increasing by 146 percent. The Business sector increased its resource input to R&D by 72 percent between 1994 and 2004, while the CRI sector had a small decline. The average annual rate of increase for the University sector (post-graduates plus staff) was seven percent, and for the Business sector it was about six percent.

In terms of their contribution to the overall growth in human resource input into R&D, Table 2.4 shows us that the University sector was responsible for 78 percent of the growth over the period, the Business sector contributed 27 percent while the input by the CRI sector declined by six percent.

Analysis of the contributions to growth based on human resource input provides quite a different picture from that obtained earlier based on the study of R&D expenditure. In the previous analysis, the University and Business sectors contributed almost equally to the growth of New Zealand R&D expenditure. However, the additional impact of the R&D performed by post-graduate students in the University sector makes that sector clearly the most dominant sector when considering the human resources that are devoted to R&D.

TABLE 2.4

CONTRIBUTIONS TO GROWTH IN HUMAN RESOURCES DEVOTED TO R&D, BY SECTOR, 1994–2004

SECTOR	2004	Growth 1994–2004 (No. of FTEs)	Growth 1994–2004 (%)	Contribution to overall growth (%)
Business	4,685	1,959	72	27
University: post-graduate effort	6,885	2,864	71	40
University: staff	4,637	2,754	146	38
CRI	2,890	-405	-12	-6
TOTAL R&D	19,096	7,173	60	100

RESEARCH INTENSITY

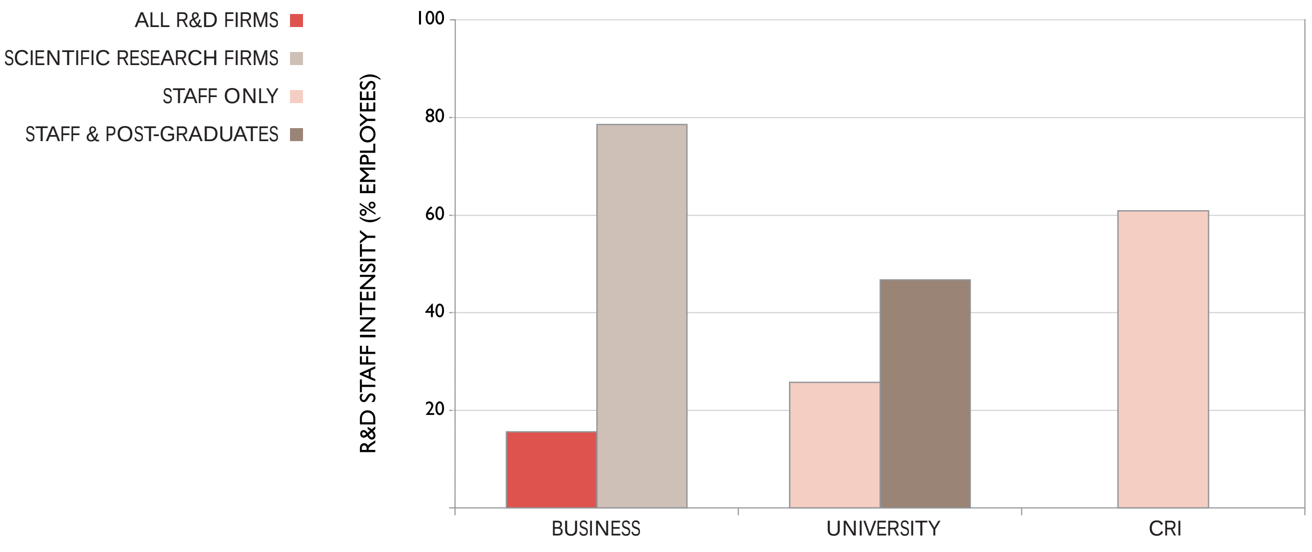
For this analysis, research intensity has been defined as the ratio of R&D effort as a proportion of total staff effort.

Chart 2.11 shows five research intensities, highlighting the large degree of variability depending upon the type and specialisation of the organisation.

As can be seen from Chart 2.11, CRIs have the greatest staff research intensity out of all sectors; that is, FTEs undertaking R&D as a proportion of total FTEs. Within the Business sector, firms specialising in scientific research, show a far greater R&D intensity than other R&D-active firms where R&D is ancillary to the primary purpose of the firm. An alternative measure of University sector intensity is also shown by the combining the post-graduate student R&D effort together with the staff effort.

CHART 2.11

RESEARCH INTENSITY, BY SECTOR, 2004



3

BUSINESS R&D

MAIN FINDINGS

- The growth rate of expenditure on R&D from 1994 to 2004 was seven percent per annum in current price terms (six percent in constant price terms). The growth rate has accelerated over the period between 2000 and 2004, to 11 percent per annum in current price terms.
- The scientific research industry has grown more rapidly than other industries, trebling its value of R&D between 1994 and 2004. This represents an annual growth rate of 11 percent over the whole decade.
- The scientific research industry has contributed 43 percent to the growth over the decade, significantly more than manufacturing (32 percent) and other services (23 percent). There has been a large amount of restructuring of firms into the scientific research industry over the past 10 years. There has also been strong growth in biotechnology research, which is mostly performed within the scientific research industry.
- Businesses with more than 100 employees performed 58 percent of total R&D in 2004. Businesses in this group that performed R&D spent on average about $2.5 million on R&D in 2004, much more than smaller firms where the average was around the $0.5 million level.
- The proportion of firms performing R&D varies significantly by size of firm. Approximately one percent of businesses with 10 to 20 employees perform R&D, compared with eight percent for businesses with more than 100 employees.
- There is a heavy concentration of R&D in the largest R&D-performing businesses. The largest five R&D performers in New Zealand contribute almost 25 percent of the total R&D, the top 10 contribute about 35 percent and the top 50 contribute about 65 percent of total business R&D.
- Funding for R&D is mainly sourced from a firm's own funds - 65 percent overall. Funding sourced from overseas has shown a very large percentage increase since 1994, but from a small base.
- The estimated human resource (FTEs) devoted to R&D increased by 72 percent over the decade.
- Approximately 65 percent of the human resource input into R&D in 2004 was by researchers, with technicians contributing 20 percent and support staff 15 percent. The contribution of the researchers category has increased at a more rapid rate than the other occupations over the decade.
- There is considerable variation between R&D intensities in different industries. The percentage of employment devoted to R&D is almost 80 percent for the scientific research industry, 20 percent for the other services sector and less than 10 percent for the manufacturing and primary industry sectors.

Credit: photo courtesy of Keratec Limited

INTRODUCTION

This chapter discusses the structure and significance of the Business sector in the performance and funding of R&D in New Zealand. This analysis is based on data that is different from that published in earlier Statistics New Zealand and MoRST reports. This is because the series used for this report has been developed to be as consistent as possible over time, whereas the series published in earlier reports were, to a large extent, developed as the best possible estimates of R&D at the point in time at which they were compiled.

A further key point of difference is that data in this report has been classified to industry based solely on the industrial classification attributed to each business by Statistics New Zealand. This differs from the practice adopted in the regular R&D Survey publications in which certain businesses have been reclassified to an industry more closely aligned to the field of research being undertaken.

A key point of difference is that the data in this chapter generally excludes R&D performed by businesses with fewer than 10 employees. Because of this, it is an incomplete measure of business expenditure on R&D (or BERD).

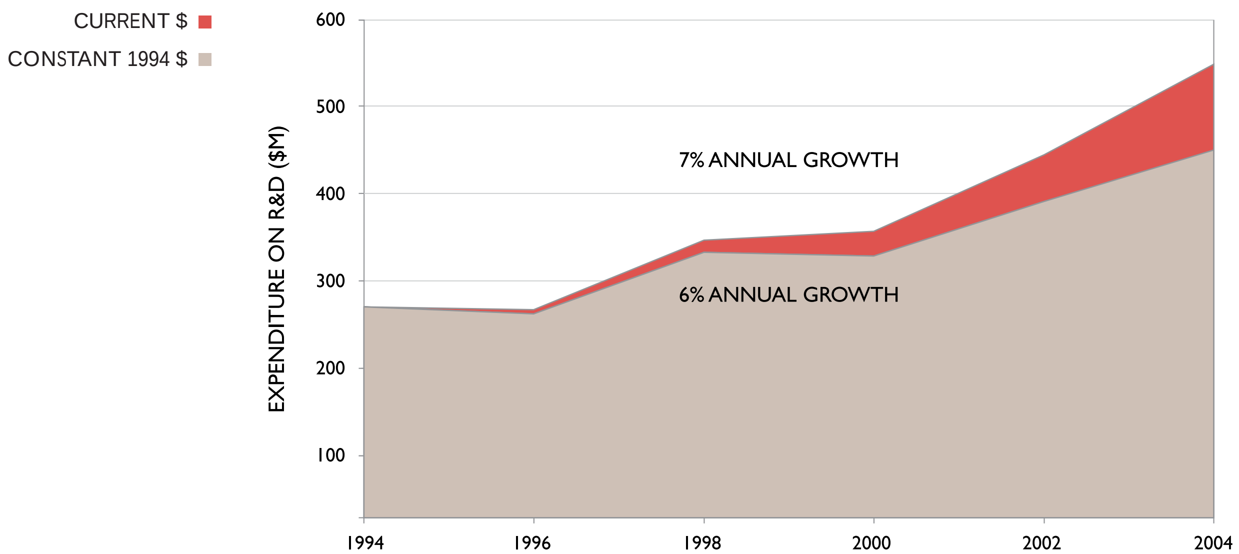
For further details on the methodology used refer to the Appendix.

EXPENDITURE ON R&D

It is estimated that there are about 584 businesses employing 10 or more people, or classified in the scientific research industry, that performed R&D in New Zealand during 2004. The level of expenditure recorded by these businesses was $550 million in 2004, more than double the amount recorded in 1994, which was $269 million. This represents an average annual growth rate over that decade of seven percent in current price terms. When allowances are made for price changes over the period, the average annual growth rate has been estimated to be six percent per annum.

As shown in Chart 3.1, Business R&D expenditure has been steadily increasing over the past decade with an apparent acceleration over the four years since 2000. In the four years from 2000 to 2004, growth in current price R&D expenditure has been estimated to be 50 percent. This represents an average annual growth rate of 11 percent over that period. By way of comparison, the average annual growth rate during the first six years of the decade being reviewed was five percent.

CHART 3.1 BUSINESS SECTOR R&D EXPENDITURE, 1994–2004

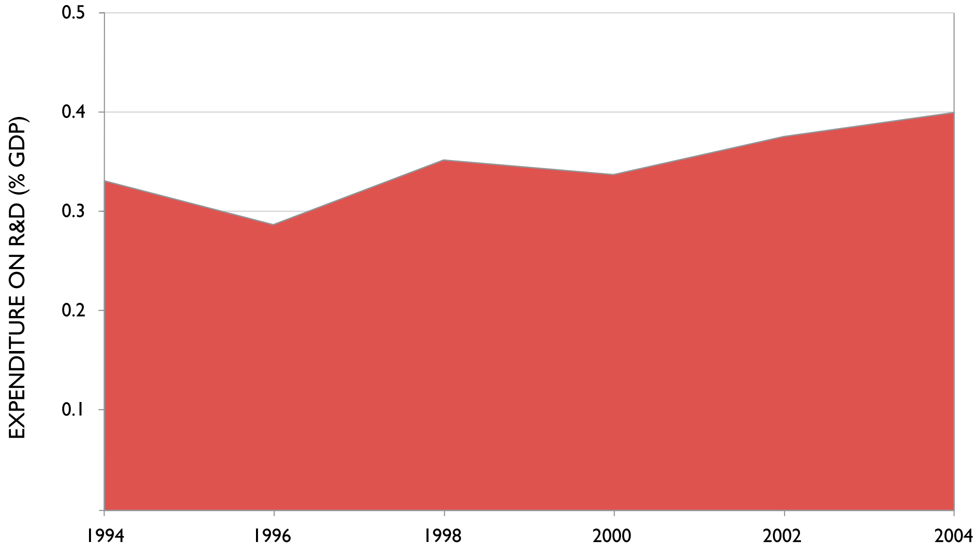


BUSINESS SECTOR R&D AS A SHARE OF GDP

One of the most commonly used indicators of sector performance of R&D is to compare R&D expenditure with **gross domestic product**, or GDP. In 1994 the estimated share of GDP was 0.33 percent; by 2004 it had risen to 0.4 percent, an improvement of some 21 percent.

Complete details are shown in Chart 3.2. This chart points to a decline between 1994 and 1996 due to an increase in GDP that was not matched by any change in R&D, followed by a sharp increase from 1996 to 1998 due to slow growth in GDP and high growth in R&D. The chart also shows the comparatively strong growth over the period 2000 to 2004.

CHART 3.2 BUSINESS EXPENDITURE ON R&D AS A PERCENTAGE OF GDP, 1994–2004



WHICH INDUSTRIES PERFORM R&D

R&D is performed in many industries in New Zealand. For the purposes of this report, the Business sector has been broken down into four industry groups - **manufacturing**, **primary**, **scientific research** and **other services** (ie, excluding scientific research). This rather minimal set of industry statistics has been chosen so that the time series developed for this report can be as consistent as possible over the past decade. However, care should be taken with the interpretation of the more disaggregated data as changes over time may be severely impacted by firms restructuring or the classification of firms to different industries in different time periods.

Chart 3.3 shows that the largest amount of R&D is conducted in the **manufacturing** industry and this has been the case throughout the period. In 2004, manufacturing businesses performed approximately $210 million worth of research, which represents nearly 40 percent of all R&D performed by New Zealand businesses.

Chart 3.3 also makes it quite clear that R&D in the **scientific research** industry has grown more quickly than other industries between 1994 and 2004. R&D performed by the **manufacturing** industry has shown consistently steady growth over the decade. The **other services** industry has also shown good growth over the decade, but its level of R&D is much lower.

There is very little R&D performed by the **primary** industry.

CHART 3.3 R&D EXPENDITURE BY INDUSTRY, 1994–2004

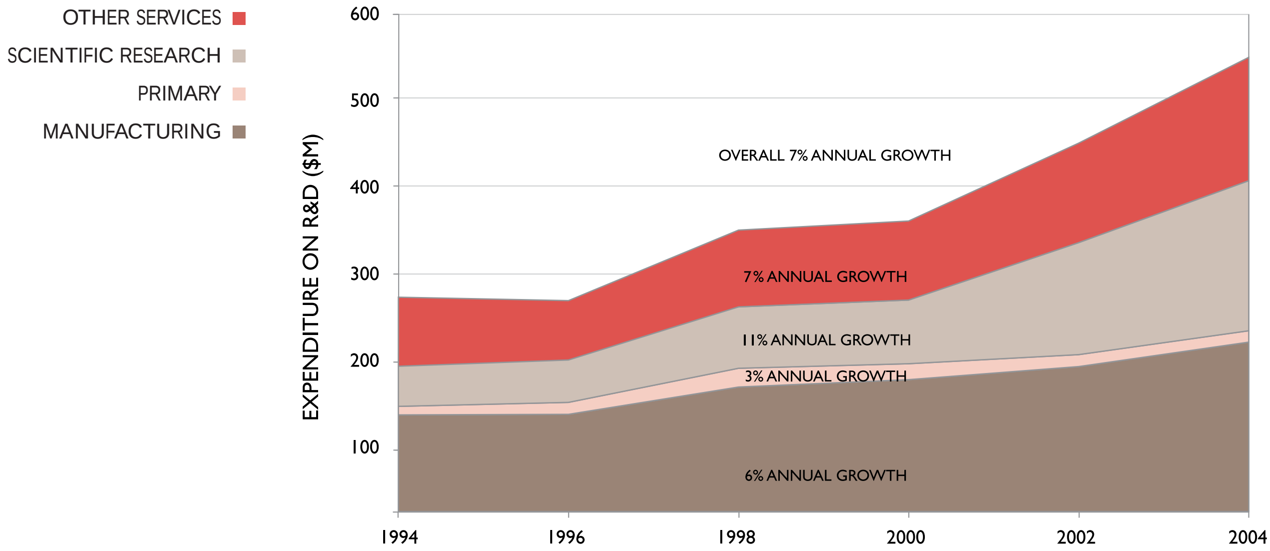


Table 3.1 below examines in more detail the growth rates of each of these industries and their contribution to overall growth in Business R&D between 1994 and 2004. This table shows an analysis of growth in current price terms, as most data is available in that form. If, however, a similar study was undertaken using industry data expressed in constant price terms, exactly the same conclusions would be drawn, the numerical answers being almost exactly the same.

As noted above, the **scientific research** industry has shown the greatest growth rate over the decade, nearly trebling its R&D expenditure over that period. This equates to an 11 percent per annum increase. The two other large industries, **manufacturing** and **other services**, have also increased substantially over the decade by amounts of 75 percent and 91 percent, respectively, equivalent to growth rates of six percent and seven percent per annum.

In terms of their contribution to total growth in the amount of R&D performed by the Business sector overall, the table below shows that the **scientific research** industry has been the dominant contributor, providing 43 percent of the total growth. The **manufacturing** industry has contributed 32 percent of the total growth and the other **services** industry has contributed 23 percent.

TABLE 3.1 GROWTH IN R&D EXPENDITURE, BY INDUSTRY, 1994–2004

INDUSTRY	R&D expenditure 2004 ($M)	Growth 1994–2004 ($M)	Growth 1994–2004 (%)	Contribution to total growth (%)
Manufacturing	212.7	91.2	75	32
Primary	14.7	4.3	41	2
Scientific research	188.3	121.5	182	43
Other services	134.0	63.8	91	23
ALL INDUSTIRES	549.7	280.7	104	100

Because of their contribution to the overall growth in New Zealand R&D, it is useful to investigate further the reasons for the growth in the **manufacturing**, **scientific research** and **other services** industries. This is discussed on page 33.

NEW ZEALAND INDUSTRIAL CLASSIFICATIONS

For readers who are less familiar with the industrial classification used in New Zealand, the notes below help to explain the distinctions between them.

- MANUFACTURING: this category includes those firms whose main activity relates to the physical and chemical transformation of materials or components into new products. It would therefore include businesses that produce food products, textiles and clothing products, wood and paper products, chemical products and metallic, non-metallic and machinery manufacturing. It excludes firms that undertake R&D into these types of product but whose main activity is the conduct of R&D. These are included in the scientific research industry.

- PRIMARY: this category includes those firms whose main activity relates to the cultivation, growing or breeding of agriculture, forestry, fishing and hunting products. It excludes firms whose activities relate to the transformation of primary products into manufactured goods (included in manufacturing) and those whose main activity is R&D into primary products (included in the scientific research industry).

- SCIENTIFIC RESEARCH: this category includes those firms whose main activity relates to the conduct of R&D into any of the sciences – agricultural, biological, physical or social – irrespective of the end objective of the R&D. It will therefore include a number of firms established with the aim of conducting R&D for specific industry sectors or specific firm groups operating in New Zealand.

- OTHER SERVICES: this category includes those firms whose main activity relates to the provision of services (other than R&D services) to the New Zealand community generally – whether the beneficiary is government, business or community groups.

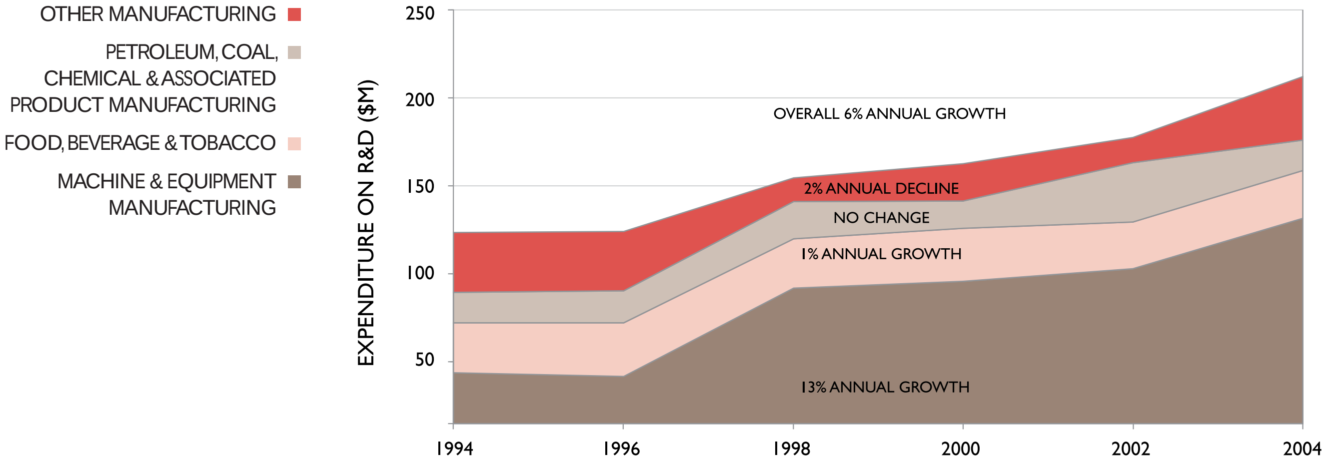
MANUFACTURING INDUSTRY

Chart 3.4 shows a dissection of the total **manufacturing** industry into industry sub-divisions according to the Australian and New Zealand Standard Industrial Classification. This clearly points out that the sub-division responsible for the increase in **manufacturing** R&D expenditure has been the **machinery and equipment manufacturing** sub-division. This industry includes electronic, electrical and appliance equipment manufacturing as well as the manufacturing of larger items of equipment. This industry has increased its R&D from $37 million to $131 million (ie, by almost $100 million) between 1994 and 2004. This represents almost the total increase being reported in **manufacturing** R&D. The increase is primarily due to an increase in the average size of R&D performers, although the number of R&D-performing units did rise by 16 percent.

R&D surveys also often classify data by the purpose of the research, by using a socio-economic objective classification or SEO. When looking at the 2004 data in terms of the socio-economic objectives of the R&D performed by manufacturing businesses, by far the largest SEO in 2004 was **materials**, **construction**, **electronics and engineering**, with the second largest being **ICT software**. These two socio-economic objectives contributed about 70 percent of the R&D being performed in the **machinery and equipment manufacturing** sub-division.

All of the other industry sub-divisions within the manufacturing industry have remained relatively unchanged.

CHART 3.4 MANUFACTURING INDUSTRY R&D EXPENDITURE, BY INDUSTRY SUB-DIVISION, 1994–2004



SCIENTIFIC RESEARCH INDUSTRY

It is not possible to dissect this industry as there are no finer dissections within the classification. Hence, to investigate what might be behind this increase, it is necessary to use the socio-economic objective classification of R&D performed by this industry. In 2004 there were three major purposes for which research was carried out by these businesses:

- **agriculture, forestry and fishing** – 40 percent;
- **industrial development** – 25 percent; and
- **health** – 24 percent.

Biotechnology research is carried out by many businesses classified to the **scientific research** industry. Of the 50 businesses classified to this industry, nearly half of them (47 percent) perform biotechnology research. This research makes up about $114 million (61 percent) of the total amount of research carried out in this industry. The vast majority of biotechnology R&D being performed in New Zealand is being performed by businesses in this industry.

Clearly, therefore, the increased emphasis on biotechnology R&D in New Zealand is a major reason for the increased R&D activity in this industry. It must also be noted that there has been a large amount of restructuring of firms into the scientific research industry over the past 10 years. This will also have contributed to the apparent growth of the industry.

OTHER SERVICES INDUSTRY

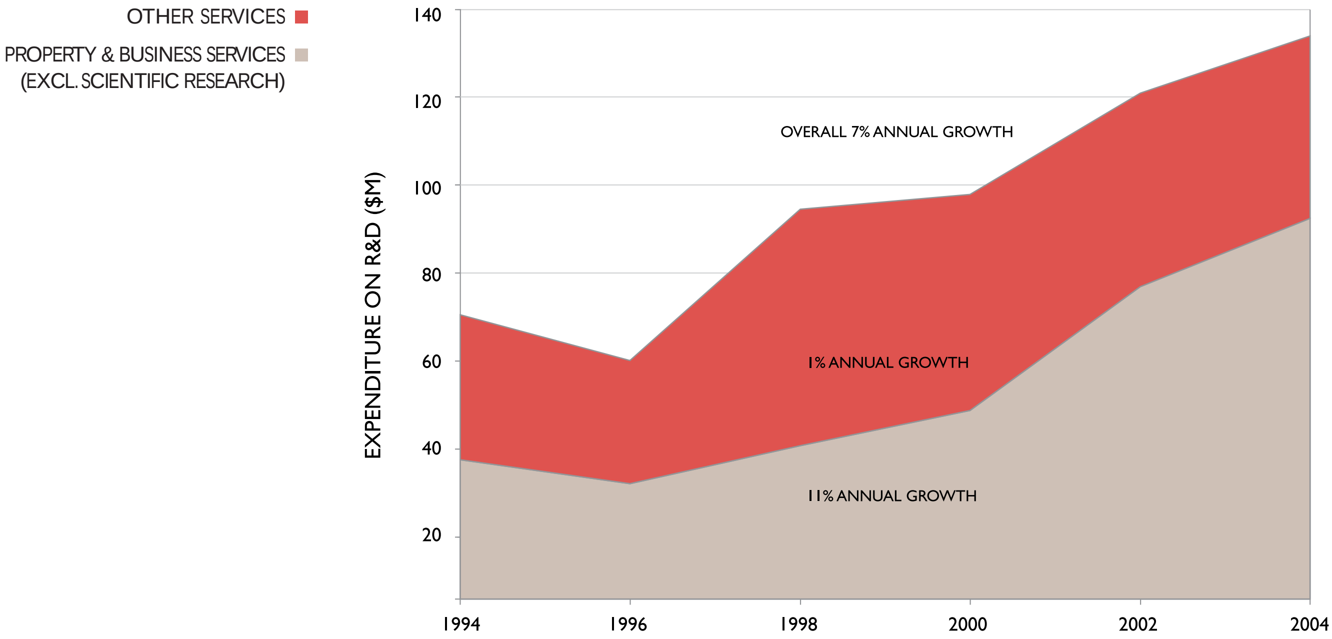
Chart 3.5 shows a dissection of the other services industry sector into the industry sub-divisions of the Australian and New Zealand Standard Industrial Classification. This chart shows that the sub-division with the greatest amount of R&D, and with the largest increase, has been the property and business services sub-division. The **property and business services** sub-division includes firms classified to the **consulting and computing services** industries, as well as other areas of business services. (Note that for this analysis, the **property and business services** sub-division excludes the scientific research industry, which falls within this sub-division in the Australian and New Zealand Standard Industrial Classification.)

The **property and business services** sub-division has trebled the amount of R&D it performs, from $34 million to $94 million (ie, by $60 million) between 1994 and 2004. This is a large part of the overall increase reported by the other services industry, and is due to an increase in both the number of R&D performing units and the average size of these units. This makes it an industry almost as important in **other services** as the **machinery and equipment manufacturing** sub-division is to the manufacturing industry. These two industries and the **scientific research** industry are the key reasons for the growth in Business R&D over the decade from 1994 to 2004.

The dominant socio-economic objective for the R&D reported in the **property and business services** sub-division has been **ICT software**, which contributes two-thirds of the R&D classified to this industry.

CHART 3.5

OTHER SERVICES INDUSTRY R&D EXPENDITURE, BY INDUSTRY SUB-DIVISION, 1994–2004



WHAT SIZE FIRMS PERFORM R&D

In this report, firms have been classified by size into four size groups:

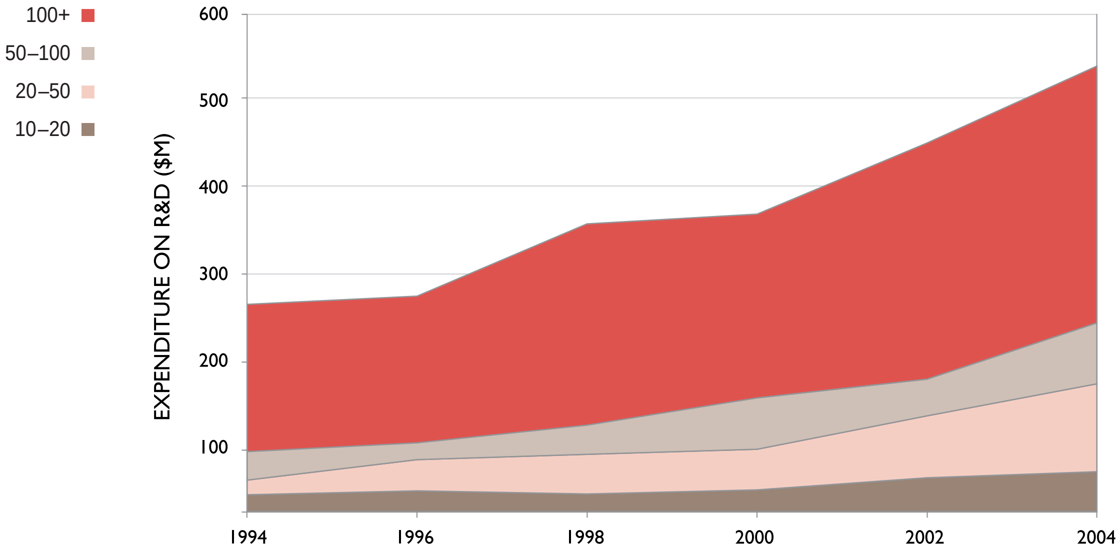
- firms with 10 or more and fewer than 20 (10 to 20) employees;
- firms with 20 or more and fewer than 50 (20 to 50) employees;
- firms with 50 or more and fewer than 100 (50 to 100) employees; and
- firms with 100 or more employees.

As discussed earlier, firms with fewer than 10 employees (other than in the scientific research industry) have been omitted from this report to ensure comparability over time. Firms with fewer than 10 employees can and do perform R&D and are important to the New Zealand science system. They have been omitted here for practical reasons concerning the consistency with which data can be identified, collected and compiled.

Chart 3.6 shows R&D expenditure classified by size of firm for the period 1994 to 2004. This chart shows that generally about half of the R&D performed by New Zealand businesses is performed by firms with more than 100 employees throughout the decade. In 2004, this proportion was 58 percent.

The other size categories each performed amounts ranging from $49 million to $107 million in 2004.

CHART 3.6 R&D EXPENDITURE, BY SIZE OF FIRM, 1994–2004



THE NUMBER OF FIRMS PERFORMING R&D

The number, and changes in the number, of firms performing R&D indicates the willingness of firms to invest in R&D. Thus it is an important indicator for the development of R&D and science policy in New Zealand.

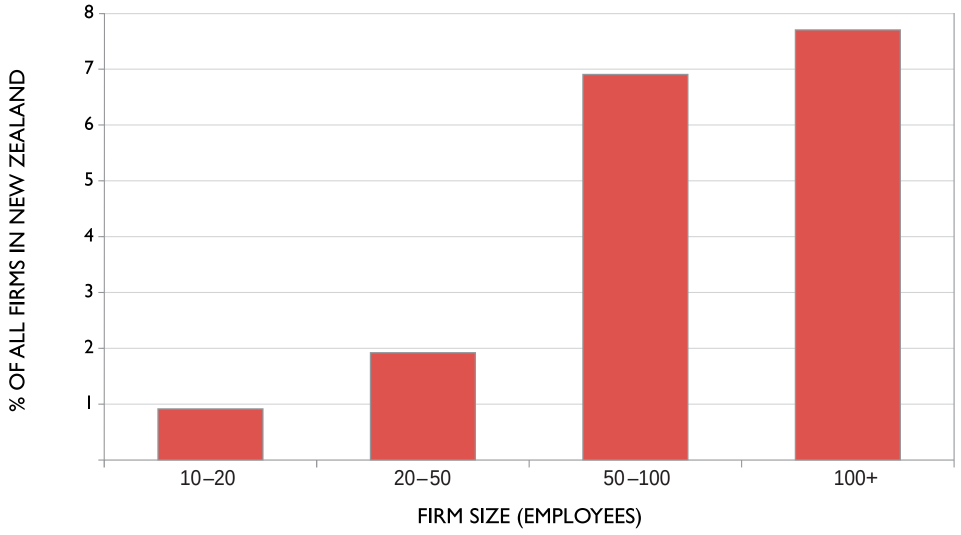
Measures of the number of firms performing R&D are subject to a lesser degree of accuracy than other statistics about R&D because of the population creation and sampling procedures adopted for the surveys. In essence this is because in compiling statistics on the number of R&D-performing firms, each R&D firm is treated equally, that is, counted as one firm with no consideration of the amount or intensity of the R&D performed. When creating the population for, or conducting the R&D surveys, each firm is not treated equally, with greater attention being afforded to larger R&D firms.

As the statistics on R&D expenditure contained in this report generally only relate to firms with 10 or more employees, so too do the estimates of the number of firms performing R&D.

It is estimated that there were approximately 561 businesses with employees of 10 or more performing R&D in New Zealand in 2004. The estimated number of firms performing R&D in 2004 for the size groups of firms referred to above (ie, with10 to 20 employees, 20 to 50 employees, 50 to 100 employees, and more than 100 employees) is almost equal, with each group containing around 100 to 150 R&D-performing businesses. In addition it is also estimated that there were a further 23 **scientific research** firms with fewer than 10 employees that performed R&D and are included in the results in this report.

However, when one expresses these numbers in terms of the proportion of all firms operating in the stated size groups, it becomes quite clear that the proportions of businesses performing R&D are not equal. Importantly, the proportions are also very small, indicating that the performance of R&D is not widespread. From Chart 3.7 it can be seen that less than one percent of firms with 10 to 20 employees perform R&D, and less than two percent of firms with 20 to 50 employees perform R&D. For larger businesses, the proportions increase significantly to around seven to eight percent of firms performing R&D.

CHART 3.7 PROPORTION OF FIRMS PERFORMING R&D, BY SIZE OF FIRM, 2004



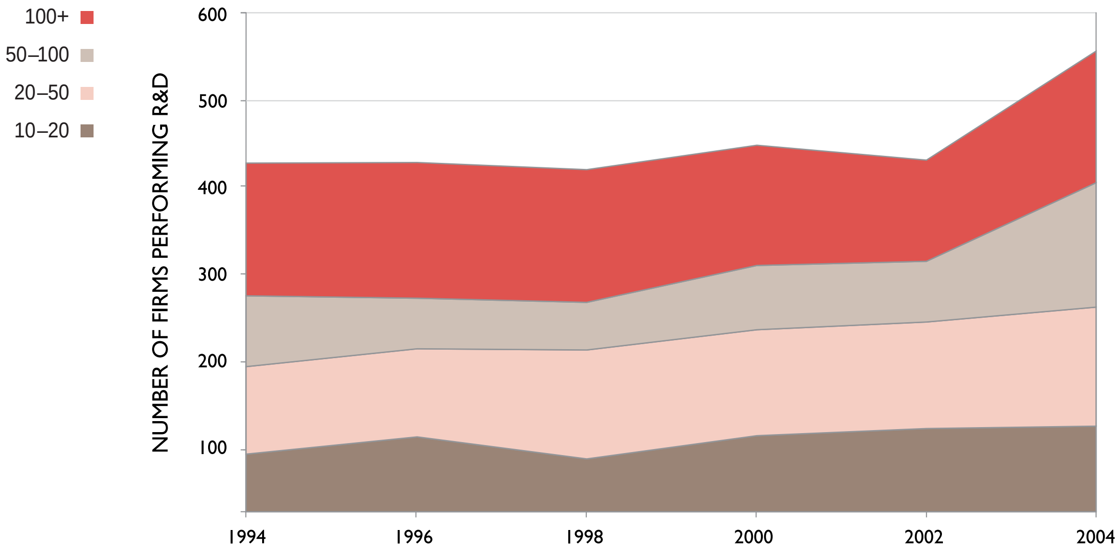
GROWTH IN THE NUMBER OF FIRMS PERFORMING R&D

Given the smallness of the proportions of firms performing R&D, it is fairly clear that obtaining even a modest increase in the proportions could lead to a substantial increase in New Zealand Business R&D expenditure. This may be possible by encouraging new firms to perform R&D or assist older firms to start performing R&D for the first time.

Shown in Chart 3.8 are estimates of the number of firms performing R&D over the past decade in the size categories discussed earlier. This shows that the numbers in each of the size categories have been quite variable over the years, partly reflecting the difficulty in being able to measure accurately the number of firms performing R&D. The numbers do, however, indicate that there is a greater tendency in more recent years for smaller firms to perform R&D.

It should be noted that, for the reasons outlined earlier, this discussion excludes firms with fewer than 10 employees.

CHART 3.8 NUMBER OF FIRMS PERFORMING R&D, BY SIZE OF FIRM, 1994–2004



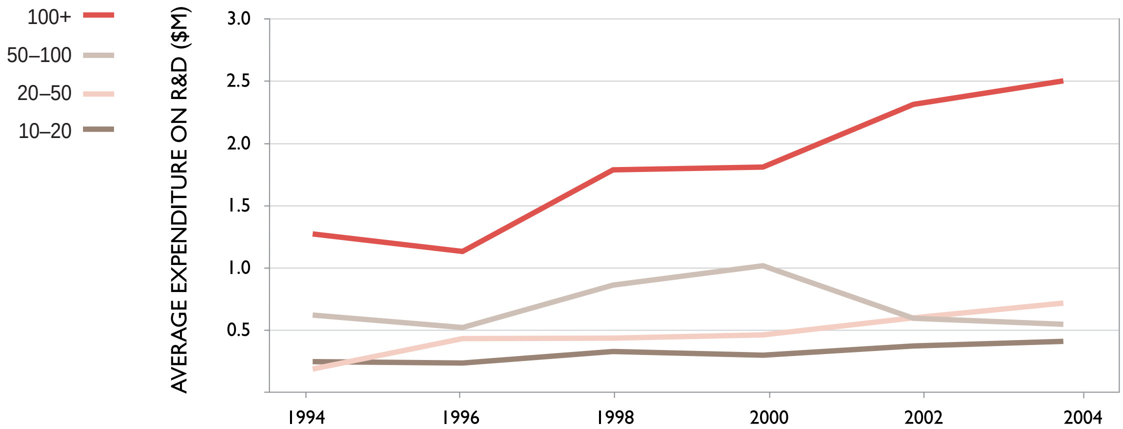
THE AVERAGE R&D SPEND OF BUSINESS

Business sector R&D can also be increased by increasing the average amount of money spent on R&D by firms performing it.

The chart below shows estimates of the average R&D spend of businesses derived from the surveys over the past decade. This shows a substantial increase in the average value of R&D performed by businesses in the 2004 survey, particularly by larger businesses. For businesses with 100 or more employees, the average spend on R&D has nearly doubled between 1994 and 2004, with the 2004 average being around $2.5 million per firm. The average spend by firms in each of the other size groups varies a little, but is generally around the half million dollar mark.

CHART 3.9

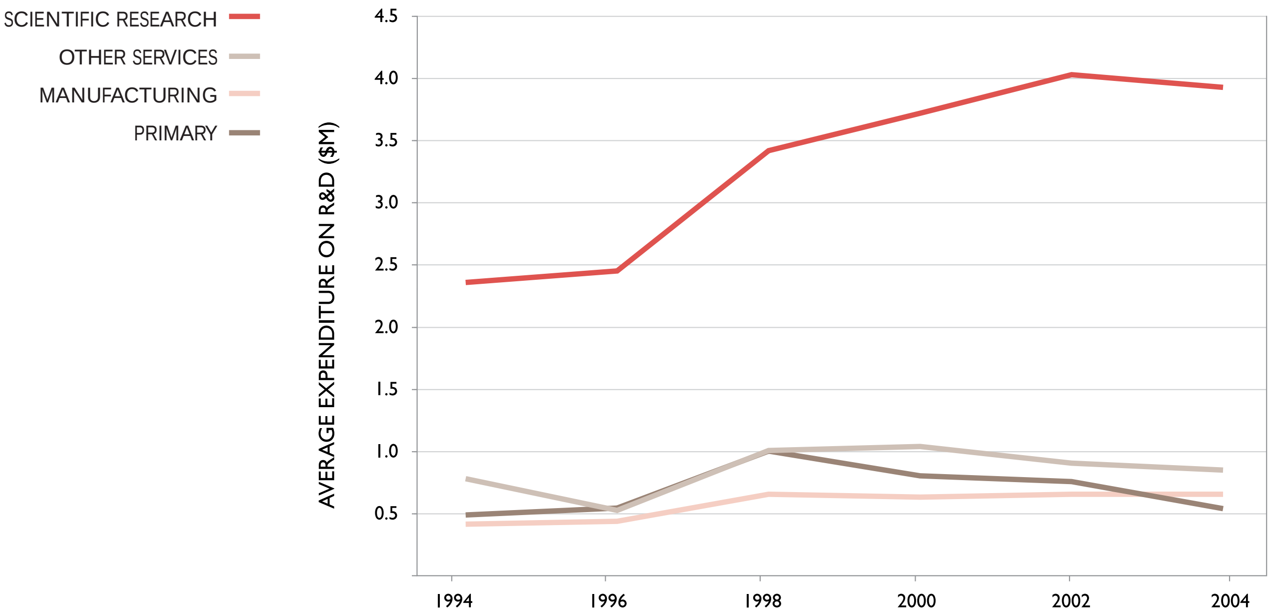
AVERAGE R&D SPEND OF FIRMS, BY SIZE OF FIRM, 1994–2004



Not only does R&D expenditure vary by size of firm, but the average spend of firms also varies by industry. The chart below shows estimates of the average spend of businesses in the various industry groupings used in this report. This chart clearly shows that the average amount of R&D being performed by **scientific research** firms was nearly $4 million in 2004, much larger than for any other industry.

CHART 3.10

AVERAGE R&D SPEND OF FIRMS, BY INDUSTRY, 1994–2004

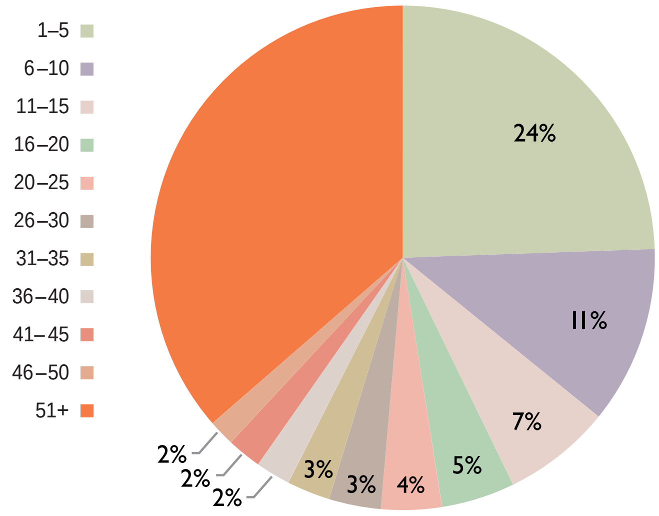


THE CONCENTRATION OF R&D PERFORMANCE

An important feature of New Zealand R&D is the extent to which it is concentrated in a small number of firms. This concentration can be shown by examining the contribution of the largest R&D-performing firms. One way of demonstrating this concentration is to compare the contribution to the total business sector R&D of groups of firms ranked in order of size of their R&D expenditure. This is presented in the chart below.

Chart 3.11 shows that the largest five R&D-performing firms contribute 24 percent of total Business R&D. There is a marked difference between these five and the next largest five firms, which contribute a further 11 percent. The top 50 firms contribute 64 percent of the total Business R&D.

CHART 3.11 CONTRIBUTION OF LARGEST R&D-PERFORMING FIRMS, 2004



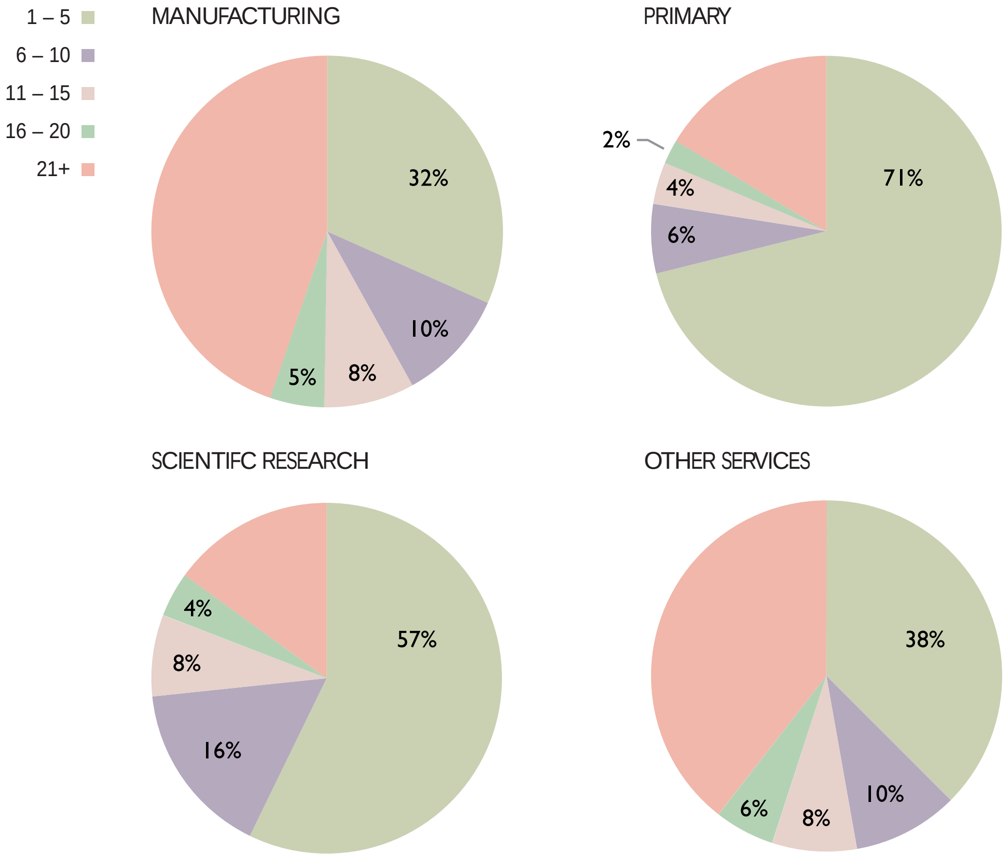
CONCENTRATION OF R&D EXPENDITURE BY INDUSTRY

Not only is the R&D expenditure for the Business sector in total skewed to the very large R&D performers, so too are the individual industries. In the chart below, the distribution of the R&D performance of the top 20 performers in each industry is shown in groups of five.

There are some quite significant differences between industries. In **manufacturing**, the five largest R&D performers contribute only 32 percent of the total R&D performed in that industry, and the top 20 contribute about 55 percent, reflecting the size of the sector and the greater relevance of R&D to manufacturing businesses.

A fairly similar result is obtained for the **other services** industry, where the top five contribute about 38 percent of the overall R&D of the sector. On the other hand, the top five performers in the scientific research industry contribute some 57 percent of the total R&D performed in the sector. In **primary** industry, the concentration of R&D effort is even more evident, with the top five contributing over 70 percent of the total R&D.

CHART 3.12 CONTRIBUTION OF LARGEST R&D-PERFORMING FIRMS, BY INDUSTRY, 2004

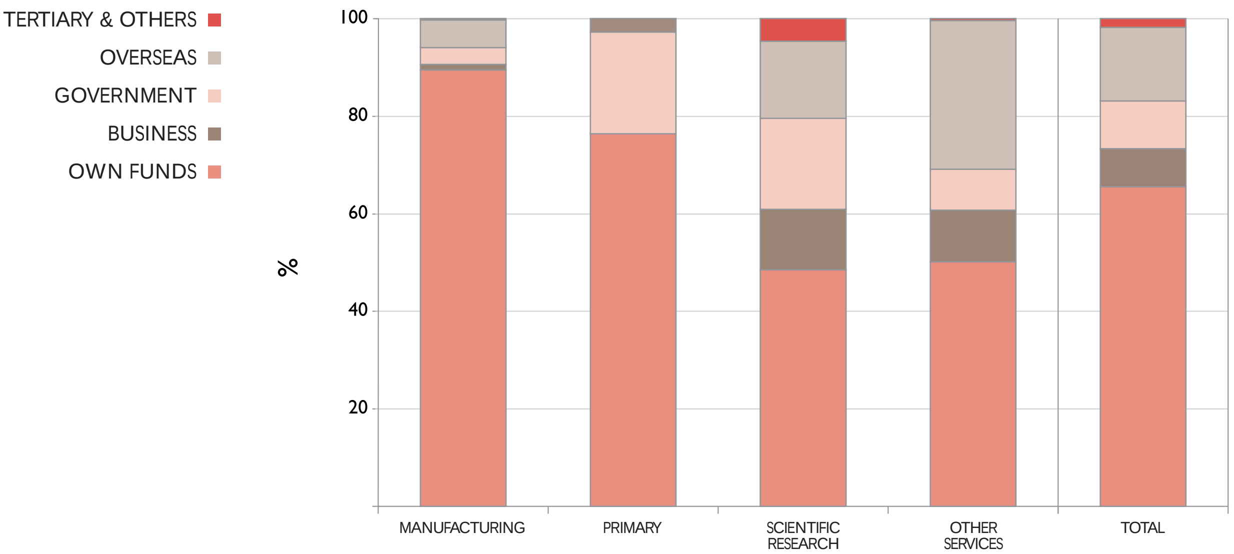


WHO PAYS FOR THE RESEARCH

In 2004, the source of funds for the R&D performed by the Business sector was as follows:

- **own funds** – 65 percent;
- **overseas funds** –15 percent;
- **government** – 10 percent; and
- **business** (other private firms within New Zealand) – eight percent.

CHART 3.13 SOURCE OF FUNDS FOR BUSINESS SECTOR R&D, BY INDUSTRY, 2004



When compared with Australian businesses, New Zealand businesses obtain a much greater proportion of funds for R&D from **overseas** funds. In Australia this percentage is only about four percent, less than one-third of the share in New Zealand.

The above analysis of the Business sector as a whole tends to hide some different trends in funding among different industries.

In terms of R&D performed by **manufacturing** firms, about 90 percent is performed from the businesses' **own funds**, with about half the rest being paid for from **overseas** funds.

In terms of **primary** industry firms, almost 80 percent comes from their **own funds**, with most of the rest coming from other **businesses**.

The source of funds for the **scientific research** industry is also primarily from their own funds, but not to the same extent as the **manufacturing** or **primary** industries. Just under 50 percent of the R&D performed in this industry comes from their **own funds**, 19 percent is funded by **government**, and 16 percent from **overseas** funds.

For **other services** industry firms, again about 50 percent is funded from their **own funds**. However, for this industry a further 30 percent of the funding comes from **overseas** funds with another nine percent coming from **business**.

The results are shown diagrammatically in Chart 3.13.

GROWTH IN R&D BY SOURCE OF FUNDS

When the funding of Business R&D is looked at over the decade from 1994 to 2004, it shows that, in percentage terms, there have been very substantial increases in funding from **overseas** funds and from **other** funds (which includes the Lottery Board, Cancer Society and charities) which have increased by more than 10 times the amounts recorded in 1994. However, it is important to remember that these increases were from very small bases.

In terms of the overall contribution to growth in R&D, businesses' own funds contributed the largest amount (60 percent). **Overseas funds** contributed 27 percent of the total growth with most of the remainder coming from **government** sources (13 percent).

These results are shown in the table below.

TABLE 3.2 GROWTH IN R&D EXPENDITURE, BY SOURCE OF FUNDS, 1994–2004

SOURCE OF FUNDS	R&D expenditure 2004 ($M)	Growth 1994–2004 ($M)	Growth 1994–2004 (%)	Contribution to total growth (%)
Own funds	359.8	169.1	89	60
Overseas	82.8	74.9	941	27
Government	54.5	37.6	224	13
Business	42.7	-10.3	-20	-4
Tertiary education	0.4	0.2	196	0
Other	9.6	9.2	2528	3
TOTAL	549.7	280.7	104	100

RESEARCH CONSORTIA

Research consortia funding was introduced in 2002/03 to bring researchers and end users closer together and promote collaboration among universities, Crown Research Institutes (CRIs) and businesses.

Total funding of research consortia is presently $24.8 million per annum.

There are currently 10 research consortia. They are:

- Beacon Pathway Ltd
- Lactopharma
- Meat Biologics Consortium
- Pastoral Greenhouse Gas Research Consortium
- Ovita Ltd
- Pastoral Genomics Ltd
- Prevar Ltd
- Seafood Innovations Ltd
- The Radiata Pine Breeding Company Ltd
- Wood Quality Initiative Ltd.

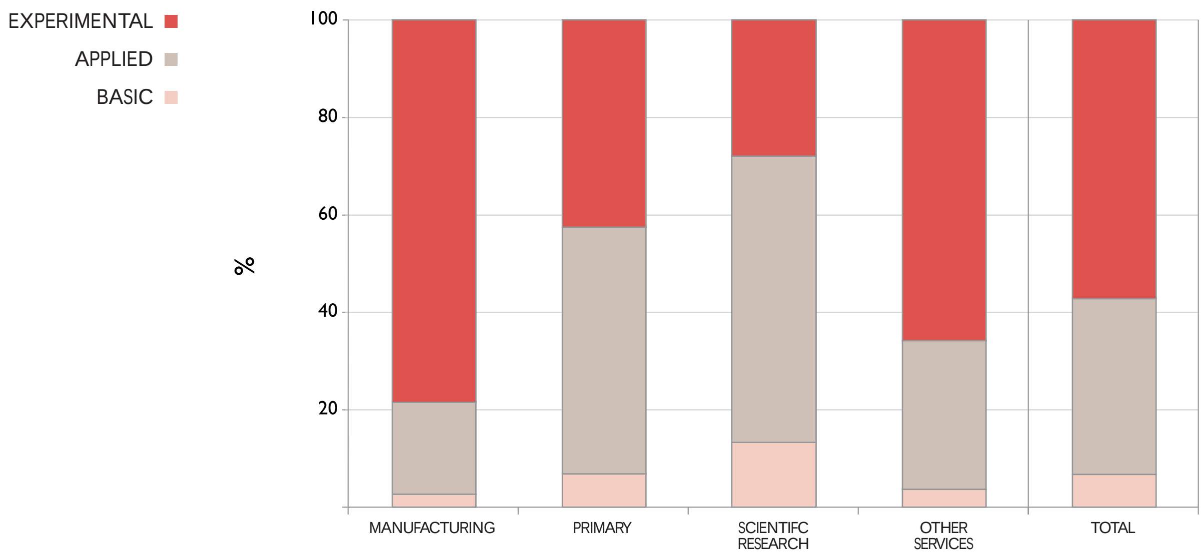
WHAT RESEARCH IS CARRIED OUT IN THE BUSINESS SECTOR

In the Business sector, only seven percent of R&D is described as **basic research**. About 36 percent of the R&D is described as being **applied research** with the remaining 57 percent being **experimental development**. This is significantly different from the distribution recorded for the CRI and University sectors, where half or more of the R&D is described as being **basic research**.

These results are shown in chart below.The **scientific research** group conducts a larger proportion of both **basic** and **applied research** than the other industries. However, the private sector scientific research industry still conducts a far greater proportion of **applied** and **experimental research** than CRIs or universities.

CHART 3.14

BUSINESS R&D BY TYPE OF RESEARCH, BY INDUSTRY, 2004



PURPOSE OF RESEARCH

Looking at the research carried out in the Business sector classified by socio-economic objective enables a different perspective to be drawn about the R&D performed in New Zealand.

In 2004, the largest socio-economic objectives were:

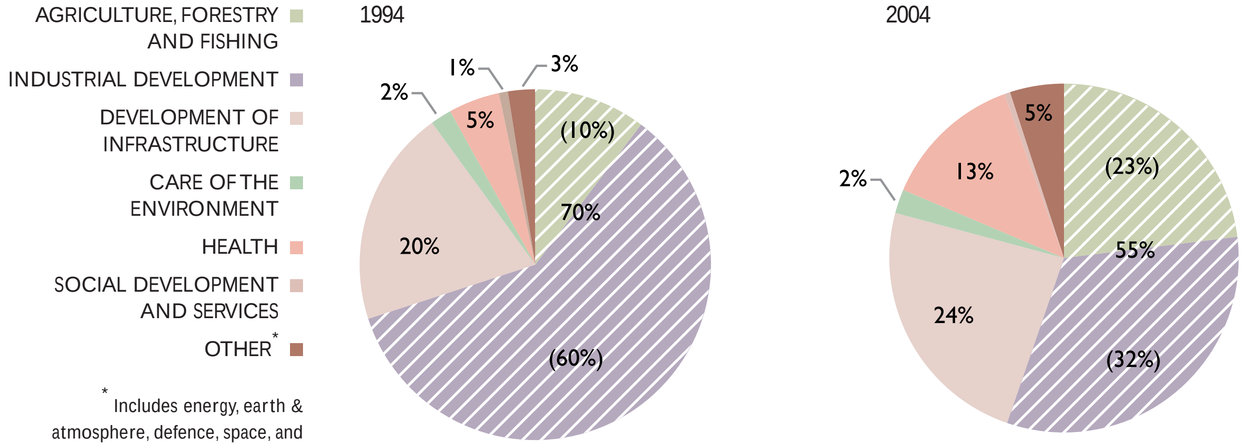
- **industrial development** (32 percent);
- **development of infrastructure** (24 percent);
- **agriculture, forestry and fishing** (23 percent); and
- **health** (13 percent).

When compared with similar data for 1994, it can be seen that there has been a significant shift in emphasis from **industrial development**, which in 1994 was the overwhelming socio-economic objective, with about 60 percent of the R&D classified to the category. It now contributes only half that amount, although it is likely that at least part of this shift will have been due to a change in the way R&D is allocated to specific socio-economic objectives.

The reduction in the emphasis on **industrial development** has been offset by substantial shifts in the amount of R&D now aimed at:

- **health** (from five percent to 13 percent);
- **agriculture, forestry and fishing** (from 10 percent to 23 percent).
  Note that this shift will have been partly due to different ways in which the socio-economic objective classification has been implemented between 1994 and 2004; and
- **development of infrastructure** (from 20 percent to 24 percent).

CHART 3.15 BUSINESS R&D BY SOCIO-ECONOMIC OBJECTIVE, 1994 AND 2004



* Includes energy, earth & atmosphere, defence, space, and knowledge general. See text box on page 23 for further definition of these categories. Some of the apparent decrease in industrial development may be due to differences in the way socio-economic objectives have been classified in the two surveys, particularly in regard to processing of products from agriculture, forestry and fishing.

The key objectives for the Business sector are vastly different from those for the CRI and University sectors where there is a lesser emphasis on **industrial development** offset by a greater emphasis on **agriculture**, **forestry and fishing** and **care of the environment** (CRI), and fundamental research aimed at **knowledge general** as well as **health** (University).

NEW ZEALAND COMPARED WITH AUSTRALIA, BY SOCIO-ECONOMIC OBJECTIVE (BUSINESS SECTOR)

It can be difficult to make precise comparisons of socio-ecomomic objective classified data with other countries as many of them do not use a socio-economic objective classification and, of those that do, many use different classifications. However, the classification adopted in New Zealand is sufficiently close to that adopted in Australia to enable some approximate comparisons with R&D carried out by the Business sector in Australia. However, it is important to remember that the classifications are different and it is not possible to make precise comparisons.

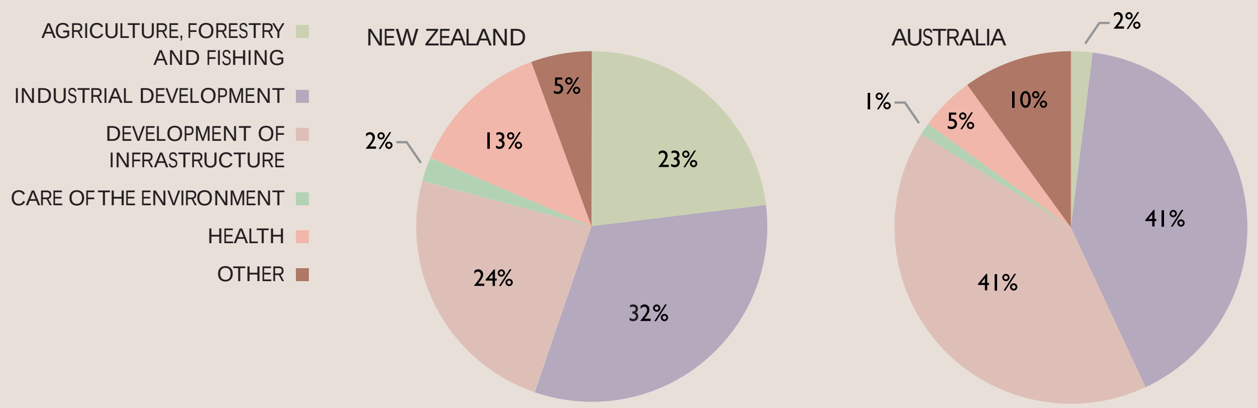
The most recent data available for Australia is in respect of the year from July 2003 to June 2004. A comparison of that data with the data discussed above for New Zealand (for 2004) shows that:

- R&D into industrial development is the most important objective in both countries. It is, however, more significant in Australia, with 41 percent compared with 32 percent;
- R&D into development of infrastructure is the second largest objective in New Zealand and equal largest in Australia at 24 percent in New Zealand compared with 41 percent in Australia;
- R&D into agriculture, forestry and fishing is much more significant in New Zealand than in Australia at 23 percent compared with two percent;
- health is a more significant socio-economic objective in New Zealand at 13 percent compared with five percent; and
- R&D into care of the environment is fairly small in both countries with about two percent for New Zealand and one percent for Australia.

These results are shown diagrammatically in the chart below.

NEW ZEALAND AND AUSTRALIAN BUSINESS R&D, BY SOCIO-ECONOMIC OBJECTIVE, 2004

SOURCE: Australian figures adapted from Australian Bureau of Statistics. *Research and Experimental Development, Businesses, Australia 2003/04*



COMPOSITION OF BUSINESS SECTOR R&D EXPENDITURE

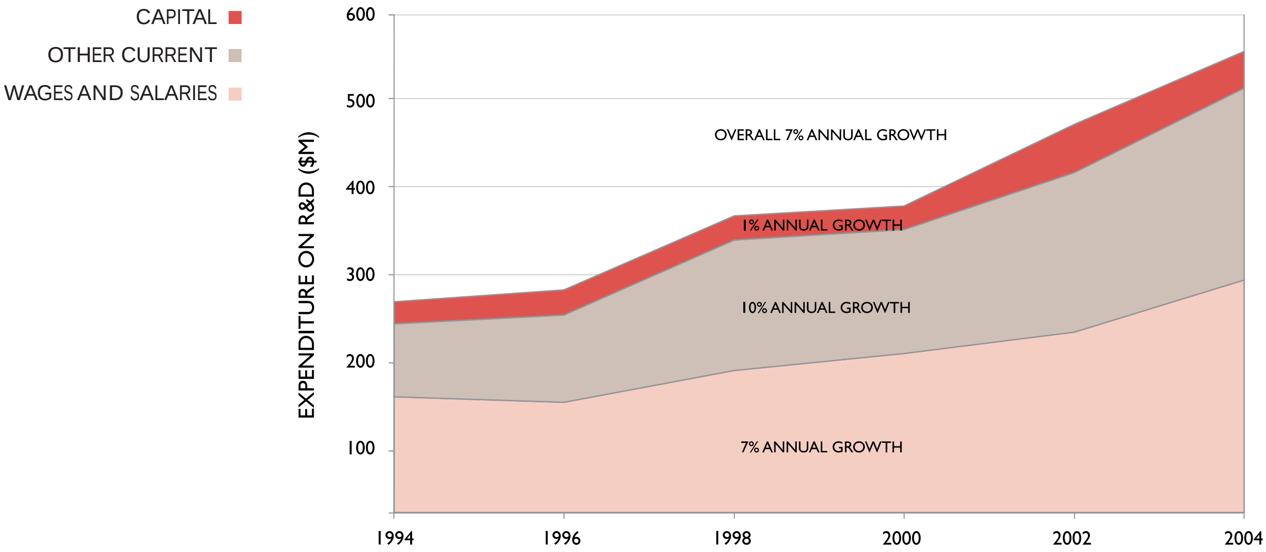
R&D surveys include a breakdown of expenditure into:

- **current expenditure** – further broken down into **wages and salaries** and **other current expenditure**; and
- **capital expenditure** – consisting of expenditure on land and buildings and other capital expenditure.

Chart 3.16 below shows **wages and salaries** to be the greatest expense in each of the years, generally proving to be about 50 percent of total expenditure on R&D. However, it is closely followed by **other current expenditure** that typically comes in at around 35 to 40 percent of total R&D expenditure. **Capital expenditure** contributed about eight percent of the total expenditure in 2004, and was a little more important in 1994, at 15 percent.

CHART 3.16

BUSINESS R&D BY TYPE OF EXPENDITURE, 1994–2004



HUMAN RESOURCES SPENT ON R&D

The Business R&D survey collects data about the personnel involved in R&D on the basis of the human resource input expressed in terms of full-time equivalent effort (FTE).

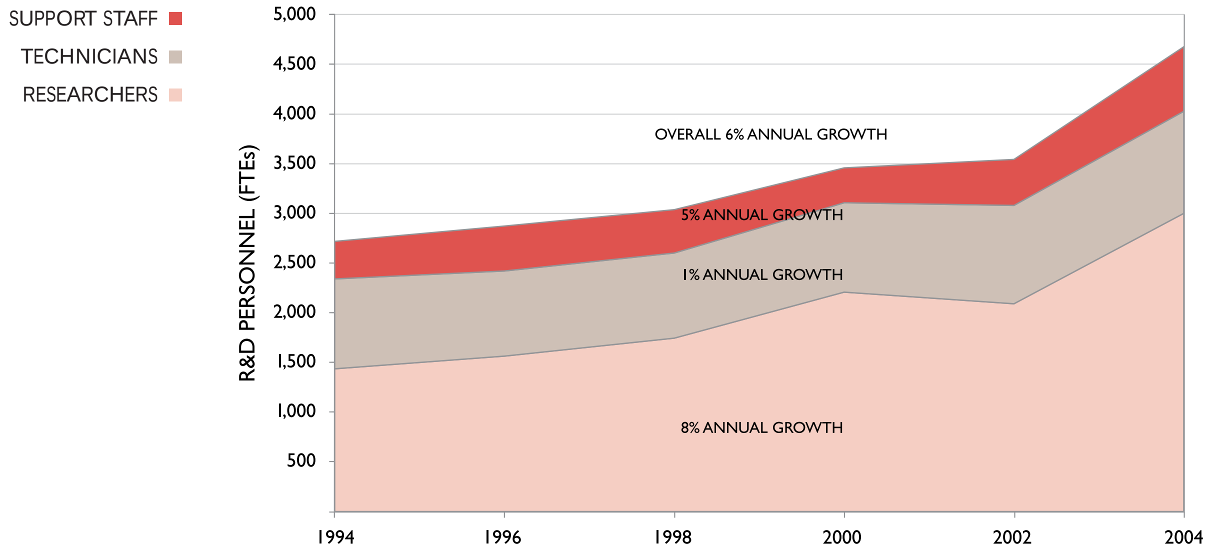
As can be seen from Chart 3.17, there has been a steady increase in the number of person years being spent on R&D over the decade from 1994 to 2004, with this number increasing from just over 2,700 to almost 4,700. This represents an overall growth of 72 percent, which equates to an average annual increase of six percent.

There appears to have been a much larger increase in the person years expended on R&D between 2002 and 2004 than in earlier years. This growth rate was estimated to be about 30 percent. For earlier periods in the last decade, the growth rate has been far more gradual.

Despite the rapid increase in the person years of R&D effort between 2002 and 2004, the growth rate over the decade has been much more in keeping with the increase in constant price expenditure noted earlier in this chapter, both at six percent per annum.

CHART 3.17

BUSINESS R&D PERSONNEL, BY TYPE OF PERSONNEL, 1994–2004



WHAT TYPE OF PERSONNEL PERFORM R&D

R&D surveys classify full-time equivalent research effort by type of personnel, broken down into groups of **researchers, technicians** and **support staff**. Data from 1994 to 2004 for the Business sector is shown in Chart 3.17 above.

This chart shows that **researchers** are the largest occupational group contributing to the R&D effort throughout the decade. In 2004 about 65 percent of the human resource input is made by **researchers**, 20 percent by technicians and the remaining 15 percent by **support staff**. The growth in human resources devoted to R&D over the decade has predominantly been due to an increase in researcher effort.

R&D PERSONNEL BY INDUSTRY

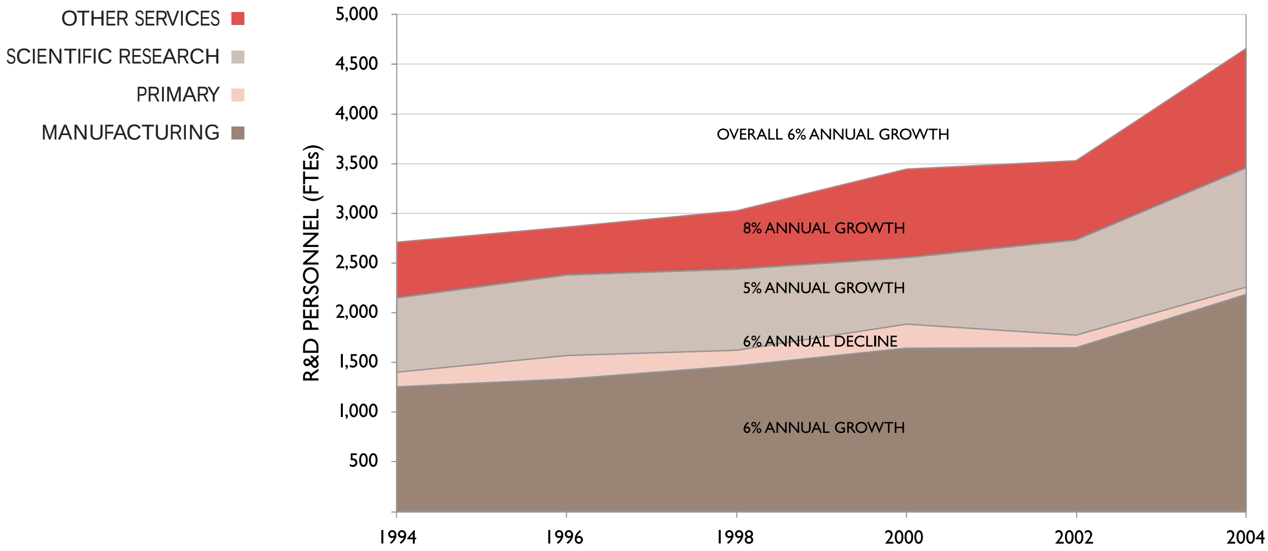
As can be seen from Chart 3.18, the **manufacturing industry** has always provided the most human resources spent on R&D. This is consistent with the finding based on the analysis of R&D expenditure data. Overall, **manufacturing** FTEs devoted to R&D between 1994 and 2004 have increased by about 75 percent over the decade, which equates to an average annual increase of six percent. This is fairly consistent with the growth rate exhibited by the expenditure data.

The **other services** industry has more than doubled its human resources input into R&D over the decade, growing at an average annual rate of eight percent. This is largely in line with the finding drawn from the analysis based on R&D expenditure data.

The **scientific research** industry has increased its human resources input into R&D over the decade by about 60 percent, which is an average annual increase of five percent. This increase is, however, much smaller than the increase shown by the comparable R&D expenditure data (11 percent). The expenditure series showed a marked acceleration between 2000 and 2004 that is not so evident in the human resources data.

CHART 3.18

BUSINESS R&D PERSONNEL, BY INDUSTRY, 1994–2004



R&D INTENSITY IN THE BUSINESS SECTOR

Not only is it important to measure the proportion of firms that perform R&D, it is also important to consider how intensively these R&D performers are actually performing R&D. There are a variety of indicators that can be used to measure R&D intensity, with the most obvious being staff input or expenditure.

For this report, intensity will be measured by considering the proportion of staff resources allocated to R&D as a share of the total employment of the firm.

Chart 3.19 maps the proportion of R&D-performing firms that utilise different proportions of their total employment on R&D. This shows that there is only a small minority of businesses that spend all or most of their human resources on R&D.

High R&D intensity firms also tend to be small. Sixteen percent of firms that perform R&D and employ 10 to 20 people spend more than 50 percent of their human resources on R&D. However, it is also important to recognise that only one percent of firms of this size actually perform R&D. Thus, as a share of all firms of this size, less than one-sixth of one percent perform large amounts of R&D.

For R&D firms with 20 to 50 people employed, less than 10 percent spend more than 50 percent of their human resources on R&D, and only two percent of firms of this size perform R&D. Thus, as a share of all firms of this size, less than one-fifth of one percent perform large amounts of R&D, which is about the same as for firms of 10 to 20 employees.

For larger R&D firms, the proportion of firms providing large amounts of their resources to R&D is even smaller. On the other hand, the proportion of firms that actually perform R&D is much larger, between seven and eight percent. Thus a similar or slightly greater proportion of all firms of this size actually commit large amounts of their human resources to R&D.

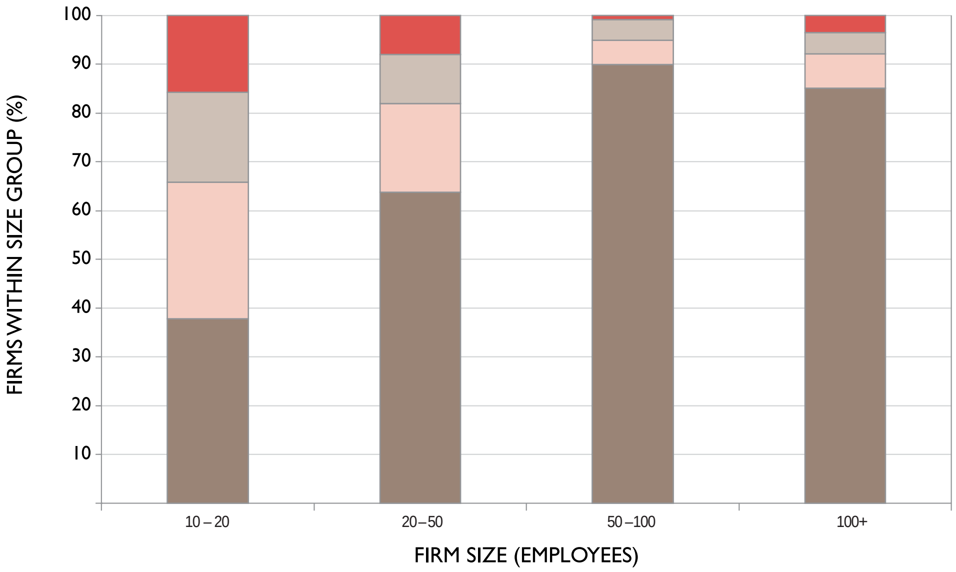
The chart also points out that for all size groups, the vast majority of all R&D-performing firms utilise less than 25 percent of their human resources on the performance of R&D, with large proportions only utilising less than 10 percent of their staff on R&D.

CHART 3.19

R&D INTENSITY, BY SIZE OF FIRM, 2004

R&D INTENSITY
(STAFF EFFORT ON R&D)

50–100%
25–50%
10–25%
<10%



AVERAGE R&D INTENSITIES

Using the R&D intensity measures for individual firms provides us with the ability to derive some average intensity measures for groups of firms, for size groups, for industry sectors and for the business sector as a whole. For the Business sector as a whole, the R&D intensity of firms that performed R&D in 2004 can be estimated at 16 percent. This can then be compared with other sectors as follows:

- **Business sector** – 16 percent;
- **CRI sector** – 61 percent;
- **University sector** (excluding post-graduates) – 26 percent; and
- **University sector** (including post-graduates) – 47 percent.

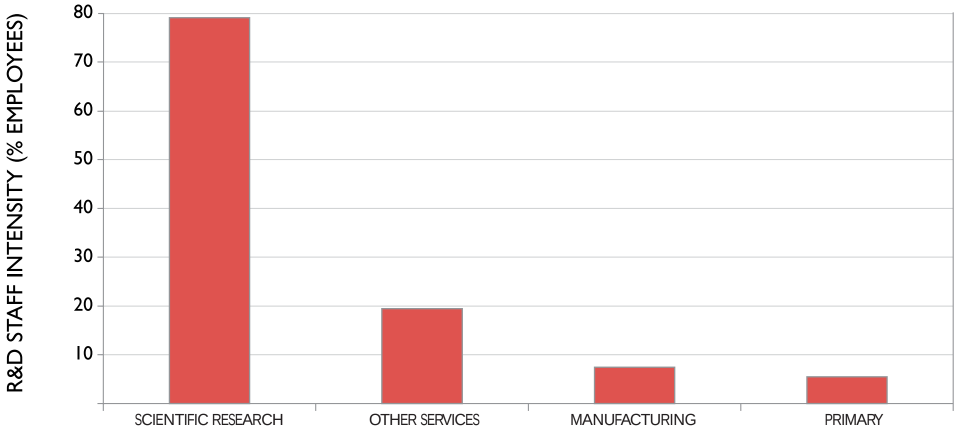
As could be expected, the R&D intensity of Business sector organisations that perform R&D is somewhat lower than for the University sector and significantly lower than for the CRI sector. If one made further allowances for the small proportion of businesses that actually undertake any R&D, the differences would be even more marked.

AVERAGE R&D INTENSITY BY INDUSTRY

Within the Business sector there is considerable variation in R&D intensities among industries. As shown in the chart below, the percentage of employment devoted to R&D by firms performing R&D is almost 80 percent for the **scientific research** industry, 20 percent for the **other services** industry and less than 10 percent for the **manufacturing** and primary industries.

CHART 3.20

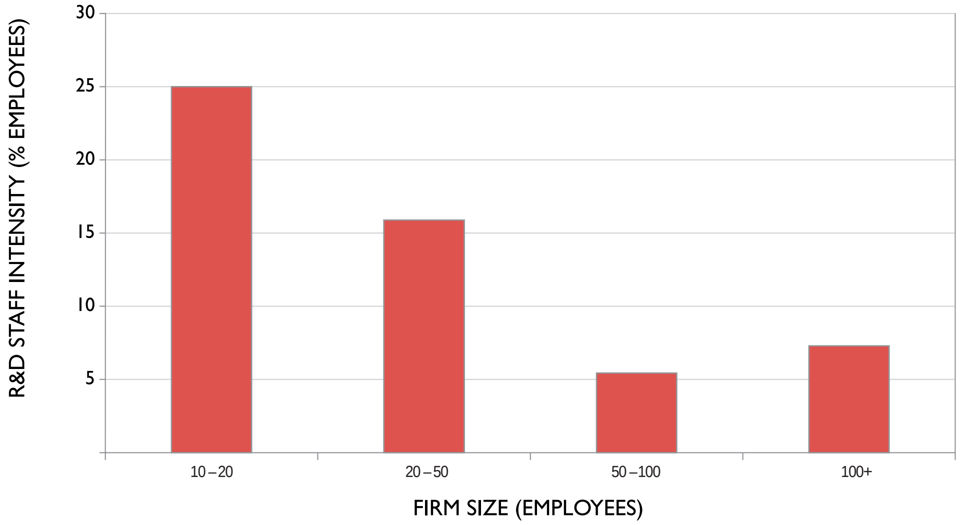
PERCENTAGE OF STAFF PERFORMING R&D, BY INDUSTRY, 2004



AVERAGE R&D INTENSITY BY SIZE OF BUSINESS

Within the Business sector there is considerable deviation of average R&D intensity by size of firm as well as by industry. Chart 3.21 below shows the average R&D intensity for each of the size groups identified earlier. This reinforces the fact that the small businesses that do perform R&D employ a greater percentage of their staff on R&D. For firms with 10 to 20 employees, their intensity is 25 percent, for businesses with 20 to 50 employees the percentage is 16 percent, and for larger businesses the intensity is just over five percent.

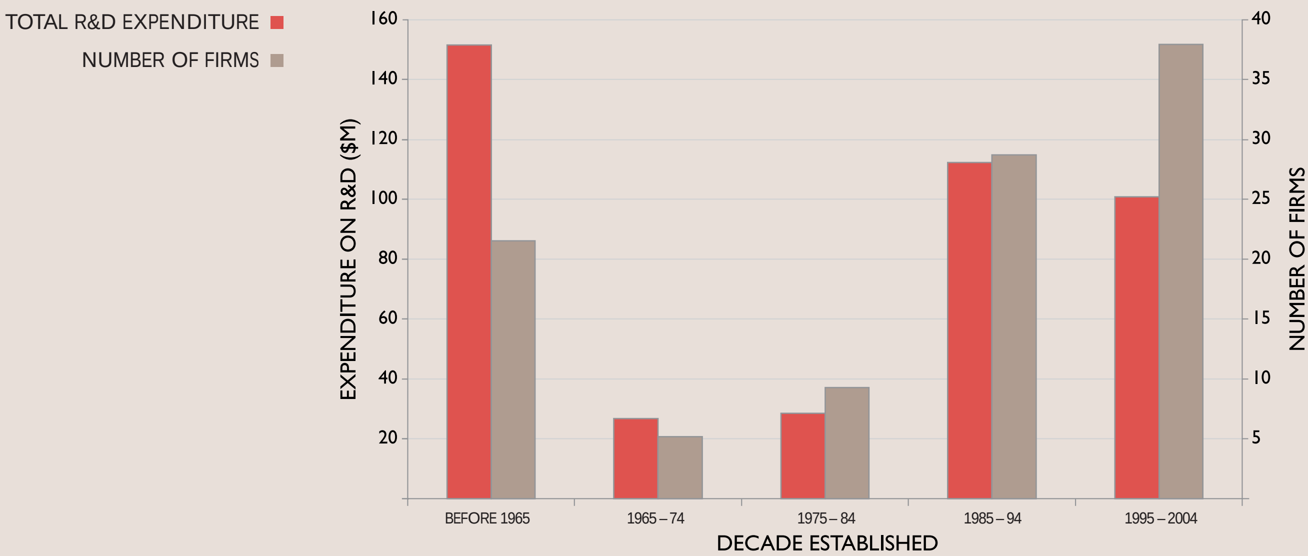
CHART 3.21 PERCENTAGE OF STAFF PERFORMING R&D, BY SIZE OF FIRM, 2004



AGE OF TOP PERFORMING FIRMS

The top 100 Business R&D performers have been classified by decade of establishment. The chart below shows the number of firms established by age, and their total R&D expenditure. There are a large number of recently established firms (less than 10 and 10 to 19 years old). The youngest firms are the lowest average expenditure. There is also a substantial number of long-established firms (over 40 years old). These old firms have the highest average expenditure. Only a small number of currently active R&D performers were established between 1965 and 1984, and they have moderate average expenditure.

TOP 100 R&D PERFORMERS (2004)




B
10 cm³
C
A

4 UNIVERSITY R&D

MAIN FINDINGS

- The growth rate of expenditure on R&D from 1994 to 2004 was 10 percent per annum in current price terms and eight percent in constant price terms.

- Auckland and Otago Universities perform about half of the R&D in the University sector and have contributed about half of the growth over the past decade.

- The University sector has increased its share of New Zealand R&D from about 20 percent in 1994 to about 30 percent in 2004.

- University sector R&D now represents about 0.33 percent of New Zealand GDP.

- The share of R&D expenditure to New Zealand GDP is low when compared with standard reference countries. It would have required an additional expenditure of $121 million in 2004 for the University sector to reach the OECD average.

- The growth in R&D has been funded in equal proportions from internal and external sources.

- The growth in external sources has mainly come from obtaining more government research contracts. This growth is common to all universities.

- The socio-economic objectives contributing most to New Zealand R&D are knowledge general (26 percent) and health (21 percent).

- There were nearly 11,000 person years of R&D effort performed in 2004. Sixty percent of this R&D effort was performed by post-graduate students.

- The growth rate over the past decade in human resource input into University sector R&D was seven percent per annum.

- The University sector has contributed nearly 80 percent towards the growth in total New Zealand R&D performance, based on human resource inputs. This compares with only a 41 percent share of growth when based on R&D expenditure.

- The intensity of R&D performance in the University sector is 26 percent based on staff performance of R&D and 47 percent when post-graduate research effort is included.

- Otago University has the highest research intensity of all New Zealand universities, based on staff performance of R&D.

INTRODUCTION

This section of the report looks at the contribution made to the performance of R&D in New Zealand by the Higher Education sector. In New Zealand, the scope of the collection is limited to universities as it is considered that the vast majority of the research in this sector is undertaken by the eight universities, namely:

- University of Auckland
- Massey University
- Victoria University of Wellington
- University of Canterbury
- University of Otago
- University of Waikato
- Lincoln University
- Auckland University of Technology (AUT).

The sector will therefore be referred to in this report as the University sector.

The R&D survey in this sector has been carried out every two years, starting from 1991. The survey in this sector of the economy is somewhat different from the other sectors in that data is estimated at a fairly aggregated level from each university using a methodology agreed to by the New Zealand Vice-Chancellors' Committee (NZVCC) in conjunction with MoRST and Statistics New Zealand. The estimation methodology is based on a number of variables including the discretionary income of universities, academic staff salaries expenditure, operating expenditure and internal and external research funding.

A feature of university operations is the degree of overlap between the teaching and research activities of academics. Separate records are not kept for the time spent on research and development for each staff member; nor are records kept at the project level. Thus it is also necessary to adopt an estimation methodology for the derivation of estimates of the staff input into research activities. In addition, it is also necessary to estimate the time spent on R&D in universities by post-graduate students who are not members of the university workforce.

Over the years, the methodology adopted for the estimation of R&D for this sector has changed fairly significantly. For this report, the time series of expenditure data for 1994, 1996, 1998 and 2000 has been recompiled using the methodology adopted for the 2002 and 2004 surveys. Hence the data for those years is different from that published previously by MoRST, SNZ and the OECD.The time series of the human resource input into R&D has also been revised to all extents possible using the current methodology. See the Appendix for further details.

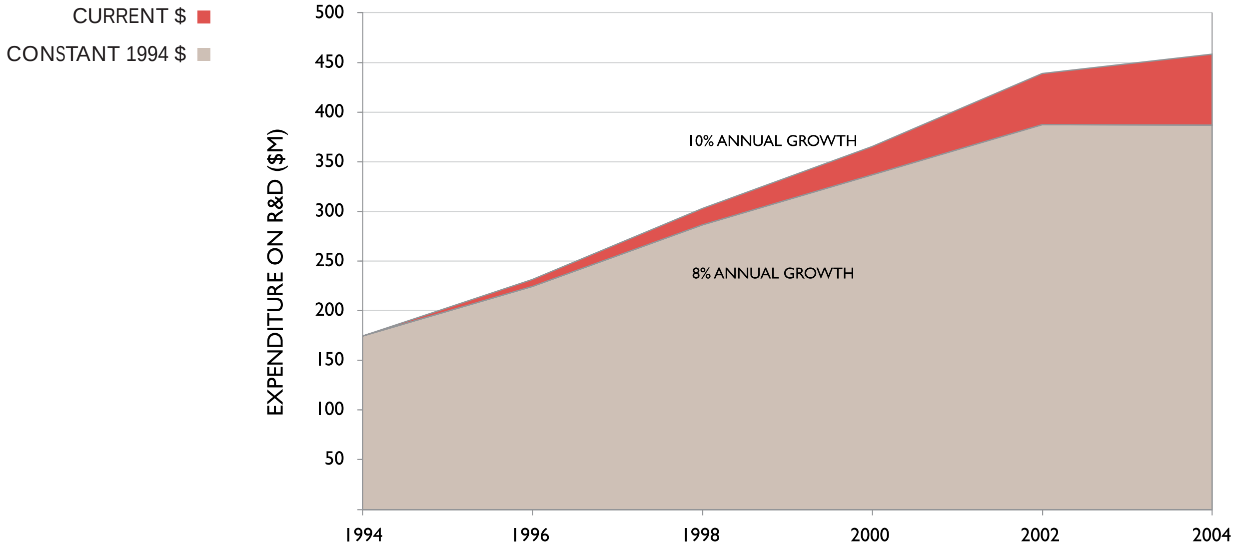
As in other sectors of the economy in which the R&D survey is conducted, data is collected about two main data items – R&D expenditure and the human resources performing R&D. These two main data items are then further broken down by a number of other classifications, some of the details of which are discussed below.

EXPENDITURE ON R&D

Chart 4.1 shows total R&D expenditure by the University sector expressed in both current and constant (1994) price terms. As can be seen from the chart, expenditure has increased by about 160 percent over the 10-year period, which equates to an average annual growth rate of 10 percent per annum. When expressed in constant price terms, the overall growth over the decade has been about 120 percent, which equates to an annual growth rate of about eight percent per annum.

Over the past decade it is estimated that the University sector has performed approximately $3.5 billion worth of research.

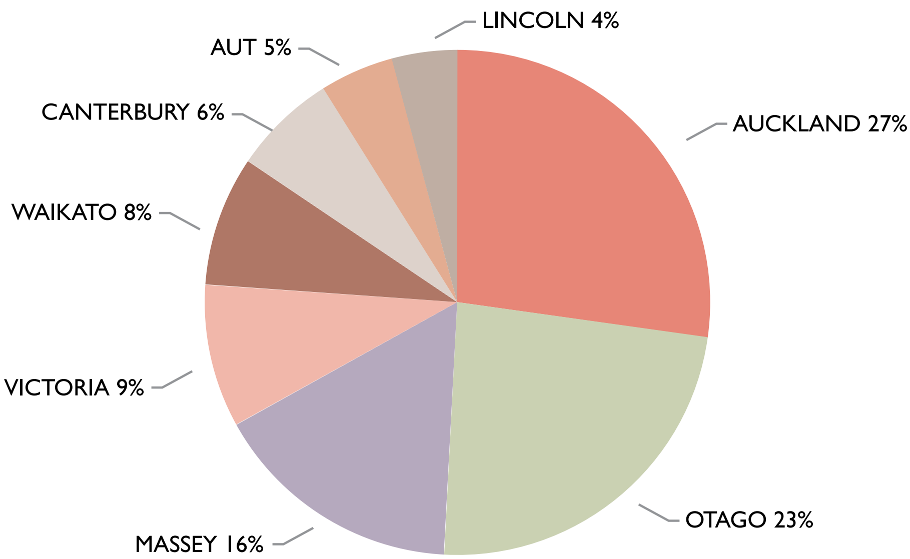
CHART 4.1 UNIVERSITY SECTOR R&D EXPENDITURE, 1994–2004



THE MAJOR CONTRIBUTORS

R&D performance in the University sector in New Zealand is heavily concentrated in a small number of universities. As shown in the chart below, the largest performers of R&D in 2004 were Auckland and Otago which contributed just over half the reported R&D in that period. A further quarter of the R&D is contributed by Massey and Victoria, with the remaining quarter being performed by the other four universities

CHART 4.2 EXPENDITURE ON R&D BY UNIVERSITY, 2004



Given the large growth in R&D in the University sector over the past decade, it is important to assess which universities have contributed to that growth. Table 4.1 shows the growth in R&D in each university and their contribution to the overall growth in R&D expenditure for the sector over the decade.

This table shows that all the universities increased their R&D expenditure by significant amounts. Victoria had the largest percentage increase in R&D expenditure over the decade, increasing its expenditure by 270 percent. Auckland and Waikato increased their R&D expenditure by slightly more than the overall average. Canterbury had the lowest rate of increase, but even in this case the value of R&D expenditure doubled over the decade.
AUT was not included in the sector in 1994.

When considering which of the universities had contributed most to the overall increase in R&D expenditure in the sector, the story is very similar to that described above for the level of R&D in 2004. Auckland and Otago have between them contributed approximately half of the growth in R&D, with Massey and Victoria contributing a further 25 percent of the growth.

TABLE 4.1 GROWTH IN R&D, BY UNIVERSITY, 1994–2004

UNIVERSITY	R&D expenditure 2004 ($M)	Growth 1994–2004 ($M)	Growth 1994–2004 (%)	Contribution to total growth (%)
Auckland	124.4	76.7	160	27
Otago	106.3	62.9	145	22
Massey	73.1	48.5	197	17
Victoria	41.9	31.5	300	11
Waikato	38.4	24.2	170	9
Canterbury	29.5	7.4	33	3
AUT	21.8	21.8	–	8
Lincoln	19.2	8.3	76	3
ALL UNIVERSITIES	454.8	281.2	162	100

COMPOSITION OF UNIVERSITY R&D EXPENDITURE

R&D surveys include a breakdown of expenditure into:

- **current expenditure** – further broken down into **wages and salaries** and **other current expenditure**; and
- **capital expenditure** – consisting of expenditure on land and buildings and other capital expenditure.

The table below shows **wages and salaries** to be the greatest expense, consisting of more than 50 percent of total R&D expenditure. **Other current expenditure** is the second largest expense, with only 15 percent of the total amount being **capital expenditure**. Due to the estimation methodology used for the University sector, which estimates R&D expenditure by using constant ratios of total university expenditure, the series is not shown over time, and reflects what is happening in the University sector more generally.

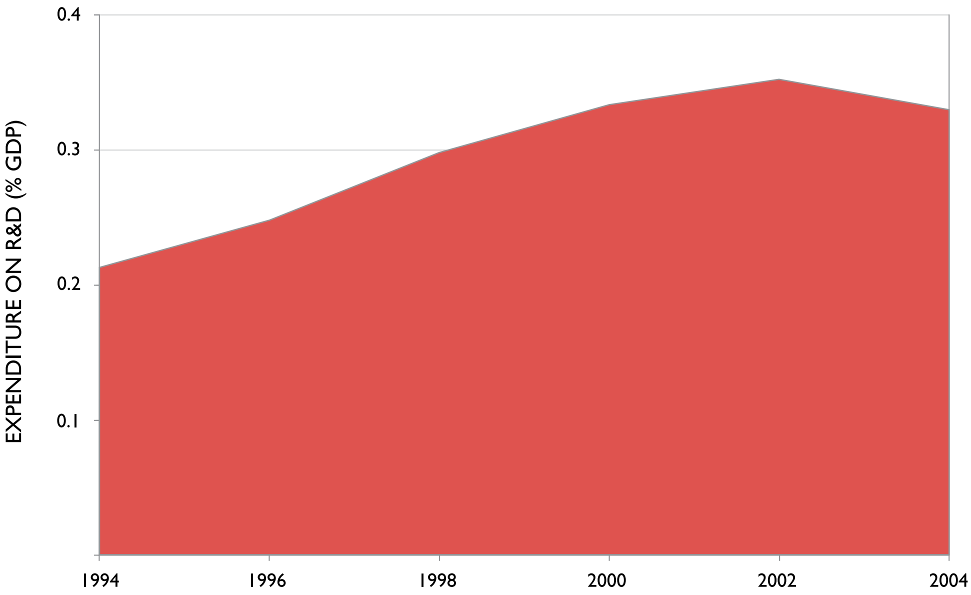
TABLE 4.2 UNIVERSITY SECTOR R&D, BY TYPE OF EXPENDITURE, 2004

TYPE OF EXPENSE	Amount 2004 ($M)	Percent 2004 (%)
Wages & salaries	238.1	52
Other current	148.7	33
Capital	68.0	15
TOTAL	454.8	100

UNIVERSITY SECTOR R&D AS A SHARE OF GDP

One of the most commonly used indicators of sector performance of R&D is to compare R&D expenditure with GDP. In New Zealand, R&D performed in the University sector represents about 0.33 percent of New Zealand GDP. This has fluctuated over the past decade, increasing from just over 0.20 percent in 1994 to a peak of 0.35 percent in 2002, followed by a small decline in 2004. This data is illustrated in the following chart.

CHART 4.3 UNIVERSITY SECTOR R&D EXPENDITURE AS A PERCENTAGE OF GDP, 1994–2004



SOURCE OF FUNDS

R&D surveys measure R&D expenditure in two ways. The most often quoted way is in terms of how much R&D is performed; however, the surveys also collect information about the source of the money to pay for this research.

As can be easily seen from the charts below, the vast majority of the funding for university research comes from:

- **own funds**;
- **General University Funds (GUF)**[1]; or
- **other government funding** (including government research contracts).

[1] Vote Education funding distributed by the Tertiary Education Commission. General University Funds (GUF) includes a PBRF component in 2004.

The overall proportion from these sources combined has been fairly consistent, ranging from about 80 to 90 percent of the overall funding. However, there has been a significant shift within these groups. In recent years there has been much more funding coming from government research contracts. In 2004 some 37 percent of the R&D came from specific **government research contracts**. In 1994 only 22 percent came from this source. Clearly, universities have become much more adept at winning government research contracts in recent years.

The share of funding coming from **GUF**, allocated by the Tertiary Education Commission (TEC) (prior to 2003 allocated by the Ministry of Education), has fallen from 38 percent in 1994 to about 27 percent in 2004. The decrease in importance of the **GUF** funded share has been because **GUF** funding has increased at a slower rate than funding coming from **government research contracts** and from universities' **own funds**.

CHART 4.4 SOURCE OF FUNDS FOR UNIVERSITY SECTOR R&D, 1994 AND 2004

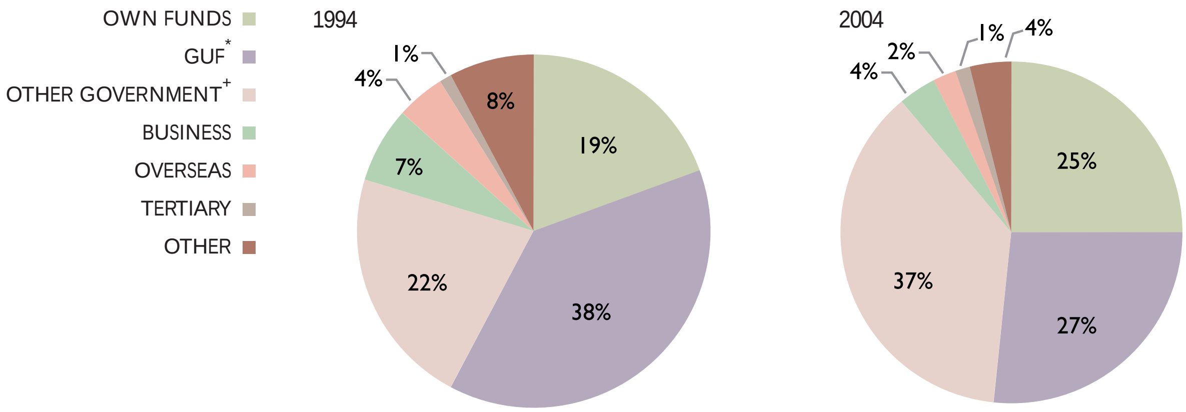


TABLE 4.3 UNIVERSITY SECTOR R&D, SOURCE OF FUNDS, 1994 AND 2004

SOURCE OF FUNDS	Amount 1994 ($M)	Amount 2004 ($M)
Own funds	33.5	113.5
GUF*	66.6	121.8
Other government+	38.2	169.0
Business	12.2	16.3
Overseas	7.7	9.7
Tertiary	1.9	6.4
Other	13.5	18.1
TOTAL R&D	173.6	454.8

* Vote Education funding distributed by the Tertiary Education Commission. General University Funds (GUF) includes a PBRF component in 2004.

+ Includes government funding agencies.

PERFORMANCE-BASED RESEARCH FUND

The Performance-Based Research Fund (PBRF) was established by the government in 2003 on the recommendations of a working party investigating research funding of the tertiary sector, and was intended to complement the move to Centres of Research Excellence (CoREs). From 2004 to 2007 the traditional form of top-up research funding, provided to tertiary institutions by government, based on student numbers (EFTS or Equivalent Full-Time Students) will be replaced with the PBRF.

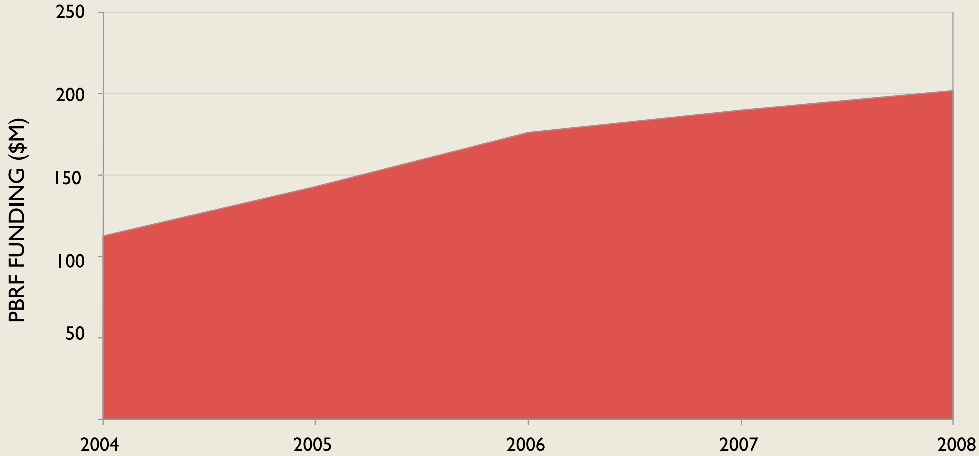
The fund has three elements, to:

- reward and encourage the quality of researchers (60 percent of the fund);
- reflect research degree completions (25 percent of the fund); and
- reflect external research income (15 percent of the fund).

The major aim of the new fund is to increase the average quality of research and allow for more standardised and transparent information about research outputs to be collected and made publicly available. The allocation of PBRF to the institutions by TEC is made as a bulk grant. The allocation of this funding within the institutions to research teams and projects is made by the institutions themselves.

RESEARCH-TAGGED VOTE EDUCATION FUNDING (INCLUDING PBRF) TO UNIVERSITIES, 2004-2008*

SOURCE: Tertiary Education Commission.



* Forecast from 2006 onwards.

CENTRES OF RESEARCH EXCELLENCE

Centres of Research Excellence (CoREs) were introduced during 2002/03 and are funded through Vote Education to encourage the development of world-class research in New Zealand. Each CoRE is hosted by a university and comprises a number of partner organisations, including other universities, CRIs and wānanga.

Total funding of CoREs is presently $25.8 million per annum.

There are seven CoREs. They are:

- Allan Wilson Centre for Molecular Ecology and Evolution
- Centre for Molecular Biodiscovery
- The MacDiarmid Institute for Advanced Materials and Nanotechnology
- National Centre for Advanced Bio-Protection Technologies
- New Zealand Institute of Mathematics and its Applications
- National Centre for Growth and Development
- Nga Pae o te Maramatanga

The funding of R&D can also be viewed by considering whether the finance is being provided directly from sources internal to each university, or from external sources. In terms of the above charts, internal sources comprise funding that universities take from their own funds or directly from the GUF that are allocated to each university from the TEC. External sources include all other sources of funds, the largest component being government research contracts, from business or from overseas. There has been a clear increase in external funding over the last decade, with the growth of external funding contributing just over half the growth in this sector.

WHAT RESEARCH IS CARRIED OUT IN UNIVERSITIES

University research can be classified in a number of ways. Two of the most common ways is for the research to be classified by type of research and socio-economic objective (the purpose of the research).

The 2004 survey showed that most of the research carried out by universities tends to be basic research, either **pure basic research** (28 percent) or **targeted basic research** (35 percent). Thus, in 2004 nearly two-thirds of university research was of this type, with most of the remainder being **applied research** (30 percent). This distribution is fairly similar to that obtained in the most recent Australian survey (2003) where **pure basic research** contributed about 28 percent of the total, **targeted basic research** about 23 percent and **applied research** about 41 percent.

TABLE 4.4 TYPE OF RESEARCH PERFORMED IN NEW ZEALAND UNIVERSITIES, 2004

TYPE OR RESEARCH	Expenditure 2004 ($M)	Expenditure 2004 (%)
Pure basic	128.7	28
Targeted basic	160.8	35
Applied	137.6	30
Experimental development	27.8	6
TOTAL	454.8	100

The distribution of research by type is different in the University sector from in other sectors of the economy. In the Business Enterprise sector, only seven percent of R&D was basic research, with 57 percent being experimental development and 36 percent being applied research. In the Government sector, where the research is mainly carried out in CRIs, nearly half of the R&D is basic research. However, in the government sector, the research is mainly targeted basic research with only a small amount of pure basic research.

PURPOSE OF RESEARCH

Looking at the research performed in 2004 by universities on the basis of socio-economic objective (or the purpose of the research), the largest objectives were:

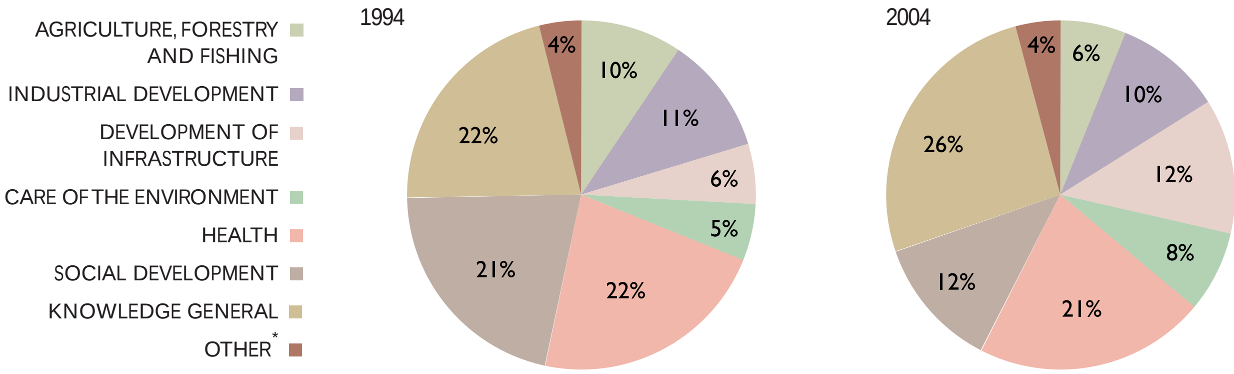
- **knowledge general**[2] (26 percent);
- **health** (21 percent);
- **social development and services** (12 percent);
- **development of infrastructure** (12 percent); and
- **industrial development** (10 percent).

[2] Knowledge general is R&D for which there is no specific objective, a lot of which is basic research.

When compared with figures from 1994, the category **development of infrastructure** showed the largest comparative increase. This may in part be accounted for by a change in classification used in the 2004 survey.

These results can be represented diagrammatically as shown below.

CHART 4.5 UNIVERSITY SECTOR R&D, BY SOCIO-ECONOMIC OBJECTIVE, 1994 AND 2004



* Includes energy, earth and atmosphere, space and defence. See text box on page 23 for further definition of these categories.

RESEARCH SPECIALISATION

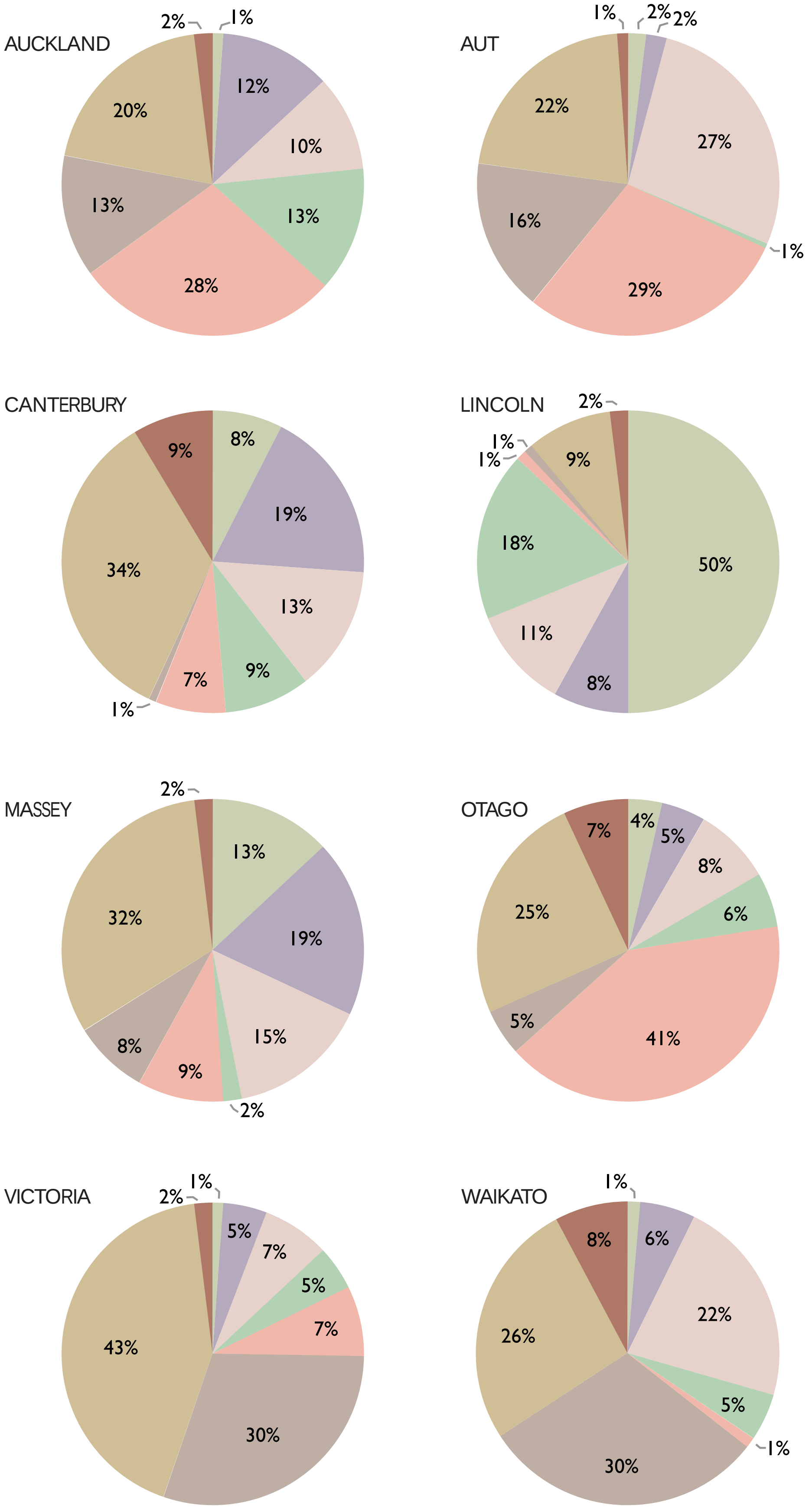
Using the data reported by individual universities, it is possible to look at the spread across universities of R&D carried out in the various socio-economic objectives. Shown below are charts describing the distribution of R&D performed in 2004 on specific socio-economic objectives by individual universities. The key points arising from this presentation are that:

- R&D into **agriculture, forestry and fishing** is heavily concentrated in Massey and Lincoln;
- R&D into **industrial development** is heavily concentrated in Massey and Auckland;
- R&D into the **development of infrastructure** is fairly generally spread around all the universities;
- 50 percent of the R&D into the **care of the environment** is performed at Auckland;
- R&D into **health** is heavily concentrated in Otago and Auckland;
- R&D into **social development and services** is spread fairly evenly around the universities although Victoria and Waikato have the highest concentration; and
- R&D into **knowledge general** is spread fairly evenly around each of the universities.

CHART 4.6 UNIVERSITY R&D, BY SOCIO-ECONOMIC OBJECTIVE, 2004

AGRICULTURE, FORESTRY AND FISHING
INDUSTRIAL DEVELOPMENT
DEVELOPMENT OF INFRASTRUCTURE
CARE OF THE ENVIRONMENT
HEALTH
SOCIAL DEVELOPMENT
KNOWLEDGE GENERAL
OTHER*

* Includes energy, earth and atmosphere, space and defence. See text box on page 23 for further definition of these categories.



NEW ZEALAND COMPARED WITH AUSTRALIA, BY SOCIO-ECONOMIC OBJECTIVE (UNIVERSITY SECTOR)

It can be difficult to make precise comparisons of socio-economic objective classified data with other countries as many of them do not use a socio-economic objective classification and, of those that do, many use different classifications. However, the classification adopted in New Zealand is sufficiently close to that adopted in Australia to enable some approximate comparisons with R&D carried out by universities in Australia. However, it is important to remember that the classifications are different and it is not possible to make precise comparisons.

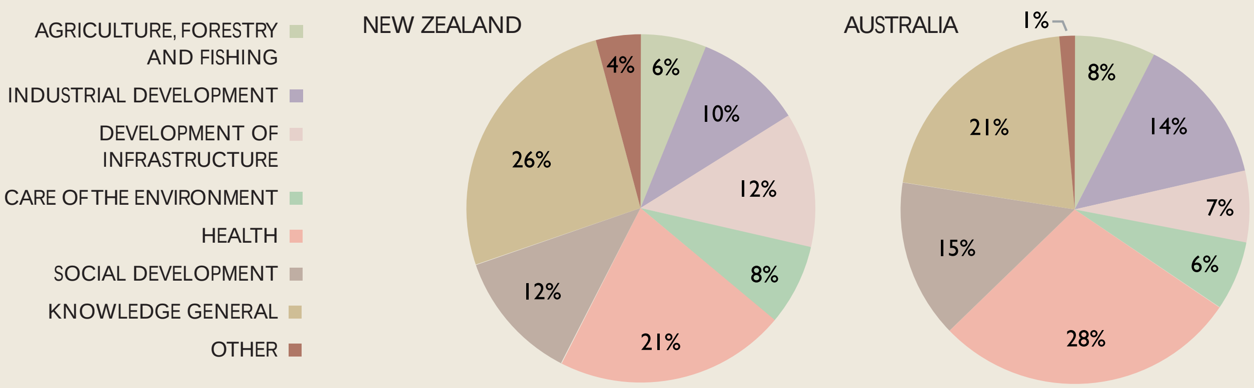
The most recent data available for Australia is in respect of the 2003 year. A comparison of that data with the data discussed above for New Zealand (for 2004) shows that:

- **health** is a significant socio-economic objective in both countries – in New Zealand it is the subject of 21 percent of the R&D, while in Australia it provided 28 percent;
- **knowledge general** is also a large component in both countries – in New Zealand it is the subject of 26 percent of the R&D, while in Australia it is 21 percent;
- R&D into **industrial development** is less important in New Zealand than in Australia – 10 percent compared with 14 percent;
- R&D into **development of infrastructure** is more important in New Zealand than in Australia – 12 percent compared with seven percent;
- R&D into **care of the environment** is about the same percentage in both countries – eight percent in New Zealand and six percent in Australia; and
- R&D into **agriculture, forestry and fishing** is also similar in both countries – six percent in New Zealand compared with eight percent in Australia.

These results are shown diagrammatically below.

NEW ZEALAND AND AUSTRALIA UNIVERSITY R&D, BY SOCIO-ECONOMIC OBJECTIVE, 2004

SOURCE: Australian figures adapted from Australian Bureau of Statistics. *Research and Experimental Development, Businesses, Australia 2003/04*



HUMAN RESOURCES SPENT ON R&D

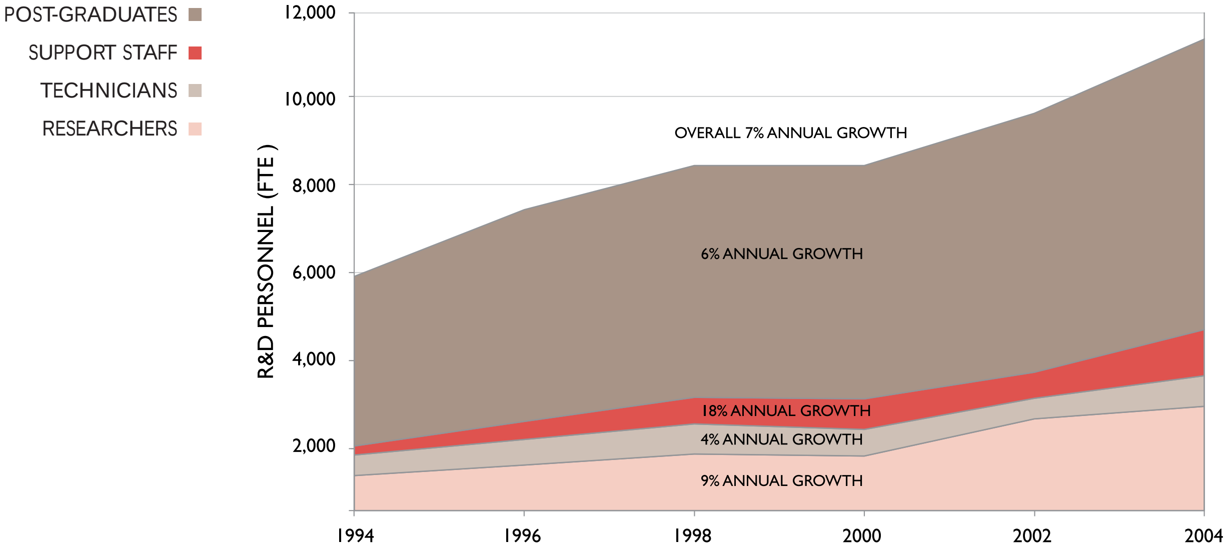
The amount and classification of human resource input into R&D performed by universities has proven to be difficult to measure over the time period that R&D surveys have been conducted. One reason for this is that data is not maintained centrally on the R&D effort performed by university staff. This has led to the adoption of estimation techniques at a fairly aggregated level, particularly in respect of the amount of research being undertaken by staff involved in both teaching and research. Over time there have also been different techniques used to estimate the R&D effort of **post-graduate** students.

There were some 11,500 staff years of effort devoted to research in 2004. Nearly 7,000 staff years of this effort were made up of **post-graduate** student effort, about 60 percent of the total effort. The remainder was provided by university staff. Academic **researchers** contributed 25 percent of the research effort, with the remaining 15 percent being made up by **technicians and support** staff.

Since 1994 the research effort in universities has nearly doubled, increasing by 95 percent over the decade. This represents an average annual growth rate of about seven percent, which is slightly less than the increase for the growth in constant price R&D expenditure over the same period.

The research effort in universities has been increasing steadily over the decade, with **post-graduate** effort increasing by 71 percent, and university staff researchers by 146 percent. The chart below shows the time series of data for **post-graduates** and university staff, separated into **researchers**, **technicians** and **support staff**, from 1994 to 2004.

CHART 4.7 UNIVERSITY R&D PERSONNEL, BY TYPE OF PERSONNEL, 1994–2004



NOTE: No staff data was collected in 1996.

In terms of their contribution to the overall growth of university sector R&D, both **post-graduates** and university staff have increased their amount of human resource input by similar amounts, with the **post-graduate** group providing 51 percent of the growth and university staff 49 percent.

R&D INTENSITY IN UNIVERSITIES

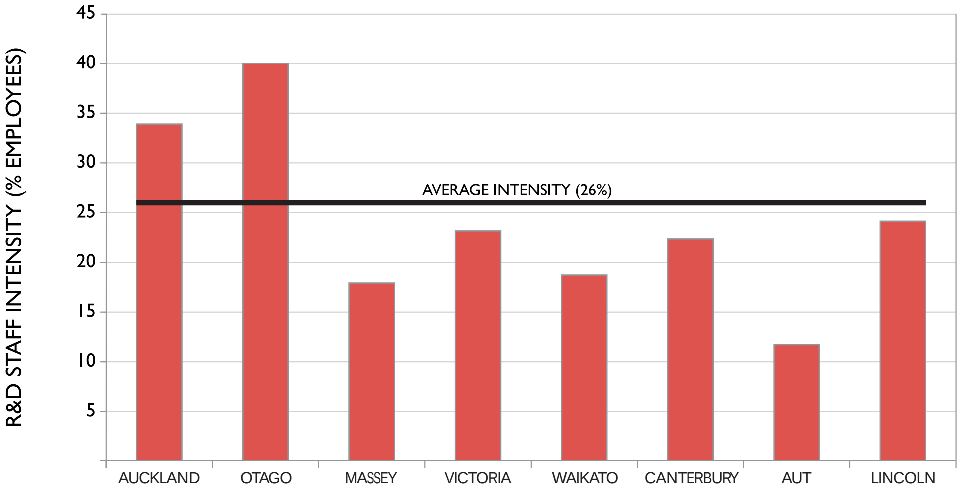
It is possible to develop a measure of the research intensity of the University sector based on their human resource input into R&D, and their total staff effort as reported in the annual reports of each of the universities.

This analysis shows that the proportion of R&D staff (excluding post-graduate students) to total workforce in 2004 was 26 percent. If, however, post-graduate students are included, both as part of the research effort and as part of the overall staff (or human resources) of each university, the share of research effort being conducted in universities rises to 47 percent.

By way of comparison, the research intensity for the Business sector was 16 percent, and the CRI component of the Government sector was 61 percent.

When one looks at the R&D intensity of each of the universities individually, it becomes apparent that Otago is the most research-intensive of the universities, with a ratio of 40 percent in 2004. Auckland is the second most research-intensive university, with a ratio of 34 percent. The comparative figures are shown graphically below.

CHART 4.8 RESEARCH INTENSITY, BY UNIVERSITY, 2004



NOTE: Canterbury's percentage is based on 2004 academic staff and 2003 non-academic staff numbers.

5

CROWN RESEARCH INSTITUTE R&D

MAIN FINDINGS

- R&D expenditure has increased by 39 percent over the decade 1994 to 2004. This represents an average annual increase of three percent.
- In constant price terms, the increase is only 15 percent over the decade, or one percent per annum.
- CRIs have spent approx $3.5 billion on R&D over the past decade.
- AgResearch Ltd was the largest R&D performer in 2004, performing almost 25 percent of all R&D performed by CRIs. However, seven of the other eight CRIs also spent significant amounts of money on R&D.
- AgResearch Ltd also contributed the most to CRI R&D growth over the period (30 percent).
- R&D expenditure on **wages and salaries** and on **capital expenditure** items remained constant over the period. Nearly all of the increase in expenditure can be attributed to **other current expenditure**.
- When expressed as a percentage of GDP, the share of CRI R&D has fallen from 0.35 percent in 1994 to 0.29 percent in 2004, a fall of approximately 17 percent.
- **Government funding and investment agencies** provided 60 percent of the funding for R&D in 2004. Ten years earlier that percentage was 73 percent. This decline has been matched by increases in funding from other sources – **business funding** increased from 13 percent to 20 percent, **overseas** funding from one percent to five percent and CRI **own funds** from four percent to eight percent.
- Half the research performed by CRIs is basic research, mainly **targeted basic research** where the R&D is undertaken to produce a broad base of new knowledge likely to underpin solutions to current or future applications.
- Human resources devoted to R&D (FTEs) have decreased by 12 percent over the decade.
- **Researcher** FTEs have increased by 10 percent over the decade, while other roles have declined – **technicians** by 17 percent and **support staff** by 46 percent.
- The average research intensity of CRIs was 61 percent in 2004.

Credit: Alan Blacklock, NIWA

INTRODUCTION

The government owns Crown Research Institutes (CRIs) to ensure that New Zealand maintains a critical mass and capability in strategic areas of science that are of long-term importance to New Zealand. Within a small economy such as ours, it is vital that both the government and local industry have access to capable RS&T institutions, undertaking excellent science, that are resident in New Zealand. CRIs are required to deliver a return to their shareholders. This return encompasses both a return on equity for shareholders and the contribution CRIs make to the government's broader economic, environmental and social goals, including maintaining scientific infrastructure and capability.

CRI revenue comes from both the public and private sector, with approximately half of their revenue coming from contestable funds administered by the Foundation for Research, Science and Technology (FRST) under Vote RS&T. Further funding from the Crown also comes from the CRI Capability Fund which assists CRIs to build and maintain research capability required for the provision of public good science. This level of government revenue means that much of the research undertaken by CRIs is strongly aligned with the Government's RS&T priorities.

CRIs were established in 1992 with the primary purpose of undertaking research for the benefit of New Zealand. In fulfilling this purpose CRIs are required by law to:

- undertake this research for the benefit of New Zealand;
- pursue excellence in all their activities;
- comply with applicable ethical standards;
- promote and facilitate the application of results of research and technological developments;
- be a good employer and exhibit a sense of social responsibility; and
- operate in a financially responsible manner so that they maintain their financial viability.

Each CRI was established around a productive sector of the economy, a grouping of natural resources or a particular public-good task, enabling each to have a clearly defined purpose and customer base.

CROWN RESEARCH INSTITUTES

agresearch

www.agresearch.co.nz

AGRESEARCH LTD

AgResearch aims to be the world's foremost pastoral sector R&D organisation, being both scientifically sound (through free-flowing innovation and a high rate of technology adoption) and financially sound. Its mission is to create sustainable wealth in the New Zealand pastoral and biotechnology sectors, through science and technology that solves real problems, provides real opportunities, and is eagerly adopted. AgResearch's ability to accomplish this mission results from its world-class core competencies in science, technology development and commercialisation.

CROP & FOOD RESEARCH
Mana Kai Rangahau

www.crop.cri.nz

NEW ZEALAND INSTITUTE FOR CROP & FOOD RESEARCH LTD (CROP & FOOD RESEARCH)

Crop & Food Research is a New Zealand-based biological science company that carries out both government-funded research and work for commercial clients. Our research is organised under five Centres of Innovation: sustainable land and water use, high performance plants, personalised foods, high-value marine products, and biomolecules and biomaterials. To promote the application of our science, we undertake research in partnership with a range of local and international industry and government clients. These research networks and collaborations enable us to contribute cutting-edge innovation and ideas, many of which we commercialise with our business partners.

INSTITUTE OF ENVIRONMENTAL SCIENCE & RESEARCH LTD (ESR)

www.esr.cri.nz

ESR - Protecting people and their environment through science. ESR' s work underpins the health and justice systems in New Zealand, providing science solutions in public health, environmental health and forensic science. The company delivers consulting and research services to the public and private sectors in New Zealand and, increasingly, the Asia-Pacific region.

INSTITUTE OF GEOLOGICAL & NUCLEAR SCIENCES LTD (GNS SCIENCE)

www.gns.cri.nz

GNS Science is New Zealand's largest provider of geoscience and isotope science research and consultancy. The company has three separate business groups: Natural Resources, Natural Hazards, and the National Isotope Centre. Revenue is generated by commercial enterprise and through competition-based government research grants. GNS Science is increasingly partnering with private sector clients to grow commercial revenue.

THE HORTICULTURE AND FOOD RESEARCH INSTITUTE OF NEW ZEALAND LTD (HORTRESEARCH)

www.hortresearch.co.nz

HortResearch is a New Zealand-based science company, acknowledged as a world leader in integrated fruit research, using unique resources in fruit, plants and sustainable production systems to provide novel technologies and innovative fruit and food products with high consumer appeal.

INDUSTRIAL RESEARCH LTD (IRL)

www.irl.cri.nz

Industrial Research provides research solutions to industry based on world-class science. Its research and development is structured around the following nine technology platforms: High Temperature Conductors and Devices; Active Surfaces/Nanotechnology; Photonics; Assistive Devices; Integrated Bioactive Technologies; Carbohydrate Chemistry; Measurement for Industry; Imaging and Detecting; and Hydrogen and Distributed Energy. Industrial Research commercialises its science through a number of mechanisms including license agreements, joint ventures and partnering arrangements.

LANDCARE RESEARCH NEW ZEALAND LTD (LANDCARE RESEARCH OR MANAAKI WHENUA)

Manaaki Whenua
Landcare Research

www.LandcareResearch.co.nz

Landcare Research specialises in the science of terrestrial environments, including all aspects of resource management for natural environments and biodiversity, biosecurity, primary production, climate change processes, resource efficiency, and low-impact urban development. Principal clients are central and local government agencies, but Landcare Research's business strategy includes increasing its focus on working with the private sector.

NATIONAL INSTITUTE OF WATER & ATMOSPHERIC RESEARCH LTD (NIWA)

NIWA
Taihoro Nukurangi

www.niwa.co.nz

NIWA is New Zealand's principal provider of environmental research and consultancy services in atmosphere and climate, coast and oceans, freshwater, fisheries, and aquaculture. NIWA's principal clients are central and local government agencies, although it is increasing its private sector revenues through the commercialisation of new products and the provision of operational forecasting services.

SCION (PREVIOUSLY FOREST RESEARCH INSTITUTE)

www.scionresearch.com
www.ensisjv.com

Scion has been recognised as a leader in forestry science since its beginnings as New Zealand Forest Research Institute in 1947. Scion has expanded its research capabilities to meet the growing consumer demand for renewable materials and products from plants. Researchers concentrate on R&D in the areas of Biomaterials Research and Sustainable Consumer Products. Ensis (the unincorporated joint venture between Scion and Australia's CSIRO) is the largest provider of R&D services to the forestry, wood and fibre industries in Australasia. With approximately 350 staff members, Scion operates from its head office in Rotorua, while Ensis has offices in Christchurch and Australia.

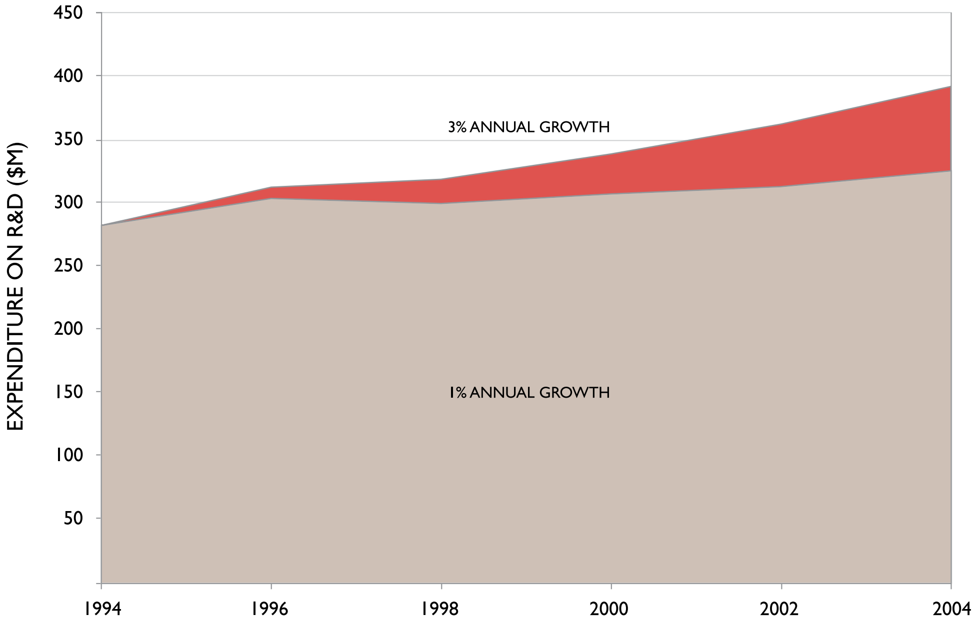
EXPENDITURE ON R&D

Chart 5.1 shows total R&D expenditure by CRIs expressed in both current and constant (1994) price terms. As can be seen, expenditure has increased by about 39 percent over the 10-year period, which equates to an average annual growth rate of three percent per annum. When expressed in constant price terms, the overall growth over the decade has been about 15 percent, which equates to an annual growth rate of just over one percent per annum.

Over the past decade it is estimated that CRIs have performed approximately $3.5 billion worth of research.

CHART 5.1 CRI SECTOR R&D EXPENDITURE, 1994–2004

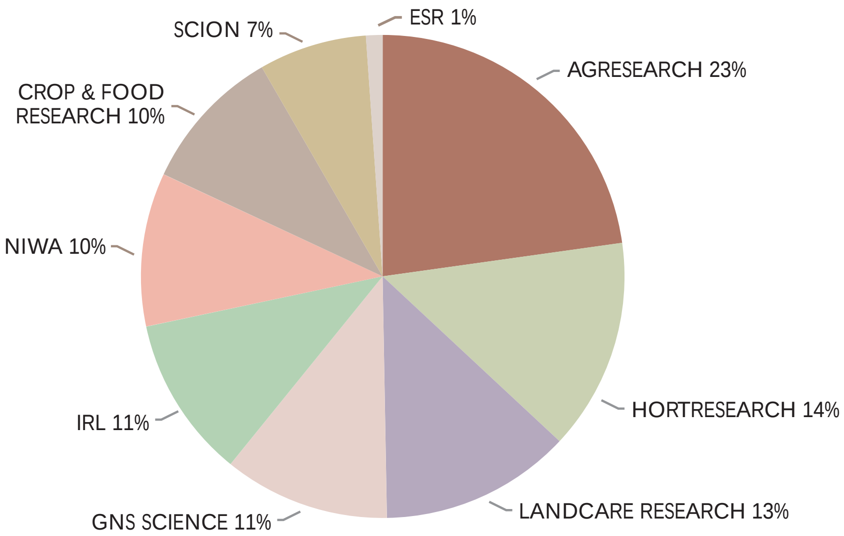
CURRENT $
CONSTANT 1994 $



CRI R&D CONTRIBUTIONS

AgResearch Ltd performs the greatest amount of R&D, contributing just under 25 percent of the total R&D performed by all CRIs. ESR performs a relatively small amount of R&D, but this is consistent with its statutory role of delivering forensic and consulting research.

CHART 5.2 SHARE OF TOTAL CRI R&D, 2004



GROWTH IN R&D

Table 5.1 shows the growth in R&D in each CRI between 1994 and 2004, and their contribution to the overall growth in R&D expenditure for all CRIs over the decade.

This table shows that there has been substantial growth in R&D expenditure over the decade 1994 to 2004 for a number of CRIs, with the largest increase being seen in GNS Science, which has more than doubled its R&D over that period. A number of the other larger CRIs have also increased their R&D expenditure by around 50 percent or more, including AgResearch, Landcare Research and NIWA.

In terms of their contribution to the overall growth in the R&D performed by all CRIs, the four CRIs mentioned above accounted for close to 80 percent of the growth.

IRL and Scion have both shown a small decrease in R&D expenditure over this period.

TABLE 5.1 GROWTH IN R&D, BY CRI, 1994–2004

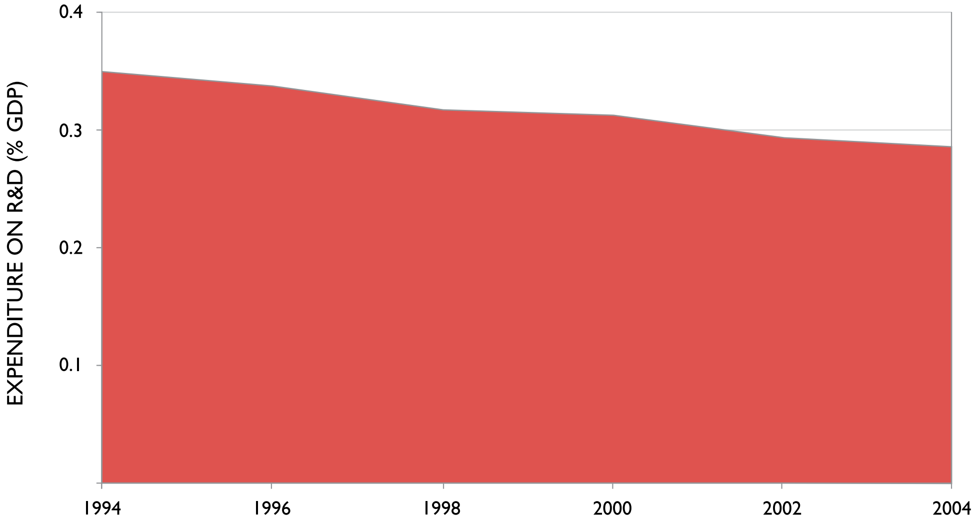
CRI	R&D expenditure 2004 ($M)	Growth 1994–2004 ($M)	Growth 1994–2004 (%)	Contribution to total growth (%)
AgResearch	89.2	33.1	59	30
GNS Science	43.6	23.4	116	21
Landcare Research	50.3	16.0	47	15
NIWA	40.6	14.5	55	13
HortResearch	56.4	12.9	30	12
Crop & Food Research	37.7	11.2	42	10
ESR	4.5	2.0	84	2
IRL	42.9	-1.2	-3	-1
Scion	28.6	-1.9	-6	-2
ALL CRIs	393.8	110.0	39	100

CRI SECTOR R&D AS A SHARE OF GDP

One of the most commonly used indicators of sector performance of R&D is to compare R&D expenditure as a percentage of GDP. In New Zealand, R&D performed by CRIs represents about 0.29 percent of New Zealand GDP. Chart 5.3 shows this has steadily declined over the past decade, decreasing from 0.35 percent in 1994. This represents a decline of 17 percent over the decade, and reflects the relatively slower growth in R&D compared with other sectors and with GDP more generally.

CHART 5.3

CRI EXPENDITURE ON R&D AS A PERCENTAGE OF GDP, 1994–2004



COMPOSITION OF CRI R&D EXPENDITURE

R&D surveys include a breakdown of expenditure into:

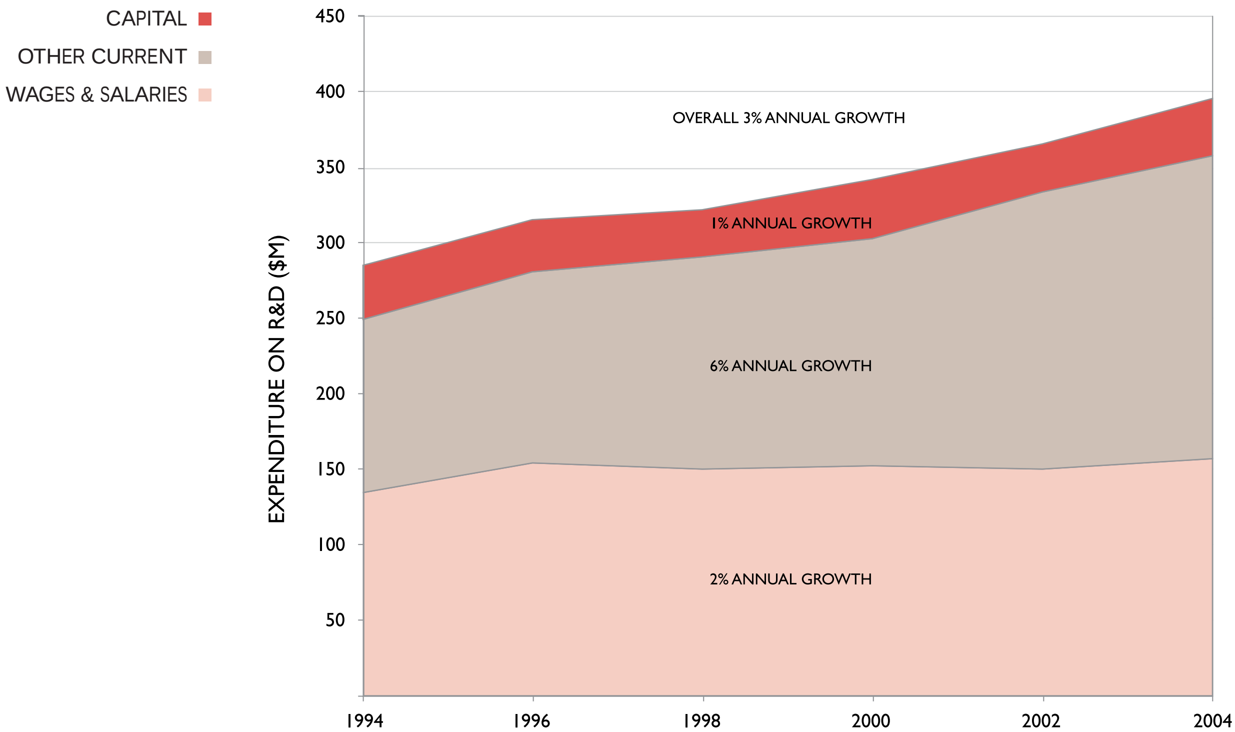
- **current expenditure** – further broken down into **wages and salaries** and **other current expenditure**; and
- **capital expenditure** – consisting of expenditure on land and buildings and other capital expenditure.

Chart 5.4 shows that in 2004 **wages and salaries** made up 40 percent of the total R&D expenditure, with the largest component being **other current expenditure** at 51 percent. **Capital expenditure** accounted for 10 percent of the total expenditure.

Over the decade 1994 to 2004, CRIs' R&D expenditure on **wages and salaries** has remained fairly constant but R&D staff FTEs have reduced. The main growth in R&D expenditure has been in **other current expenditure**.

CHART 5.4

CRI SECTOR R&D EXPENDITURE, BY TYPE OF EXPENDITURE, 1994–2004



SOURCE OF FUNDS FOR R&D

R&D surveys measure R&D expenditure in two ways. The most often quoted way is in terms of how much R&D is performed, but the surveys also collect information about the source of the money to pay for this research and who has commissioned it. However, in some cases, CRIs conduct research commissioned by a third party but funded by the government.

As can be seen from Chart 5.5, the vast majority of the funding for CRI research comes from **government funding and investment agencies** and from the **business** sector. Together, these two sources provided 80 percent of the funding for R&D in 2004.

Compared with 1994, there has been a decrease in R&D funds from government funding and investment agencies, and an increase in funding by the business sector, overseas funding and CRIs' own funds as shown below:

- **government funding and investment agencies** – from 73 percent to 60 percent;
- **business funding** – from 13 percent to 20 percent;
- **overseas funding** – from one percent to five percent; and
- CRIs' **own funds** – from four percent to eight percent.

When looking at trends at the individual CRI level, AgResearch showed the largest increase in **own funds** (internal funds) and **business funding**. NIWA had the largest increase in funding from **government funding and investment agencies**.

CHART 5.5 SOURCE OF FUNDS FOR CRI SECTOR R&D EXPENDITURE, 1994 AND 2004

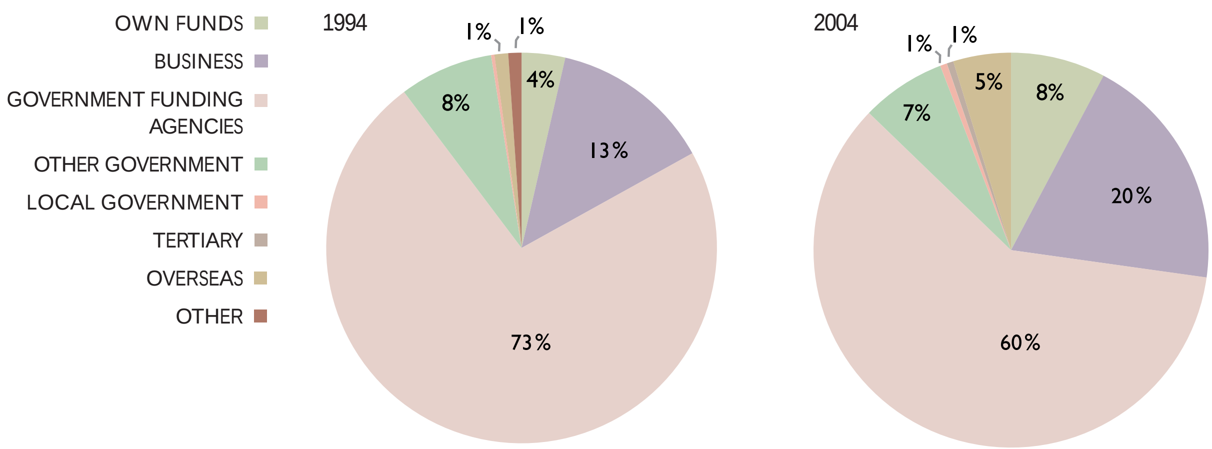


TABLE 5.2 CRI SOURCE OF FUNDS, 1994 AND 2004

SOURCE OF FUNDS	Amount 1994 ($M)	Amount 2004 ($M)
Own funds	10.3	30.1
Business	38.0	77.2
Government funding & investment agencies	206.6	236.2
Other government	21.9	27.0
Local government	0.6	2.4
Tertiary education	0.1	2.5
Overseas	3.6	18.3
Other	2.8	0
TOTAL	283.8	393.8

WHAT RESEARCH IS CARRIED OUT IN CRIs

CRI research can be classified in a number of ways. Two of the most common ways is for the research to be classified by type of research and socio-economic objective.

The 2004 survey showed that half of the research carried out by CRIs tends to be basic research, either **pure basic research** (nine percent) or **targeted basic research** (41 percent). Most of the remainder of CRI research was **applied research** (42 percent).

Based on the 2004 survey, CRIs do a smaller proportion of basic research than universities – 50 percent compared with 64 percent for universities. Moreover, the type of basic research was significantly different, with CRIs performing far less pure **basic research** than universities – nine percent compared with 28 percent, but a greater proportion of **applied research** - 41 percent compared with 35 percent. The proportion of **targeted basic research** is fairly similar between the two different types of organisation.

The CRI and the University sectors are vastly different from the Business sector in terms of the type of research that they carry out. Very little basic research is performed in the Business sector.

The type of research carried out by CRIs is shown in Chart 5.6 and Table 5.3.

CHART 5.6 TYPE OF RESEARCH PERFORMED BY CRIs, 2004

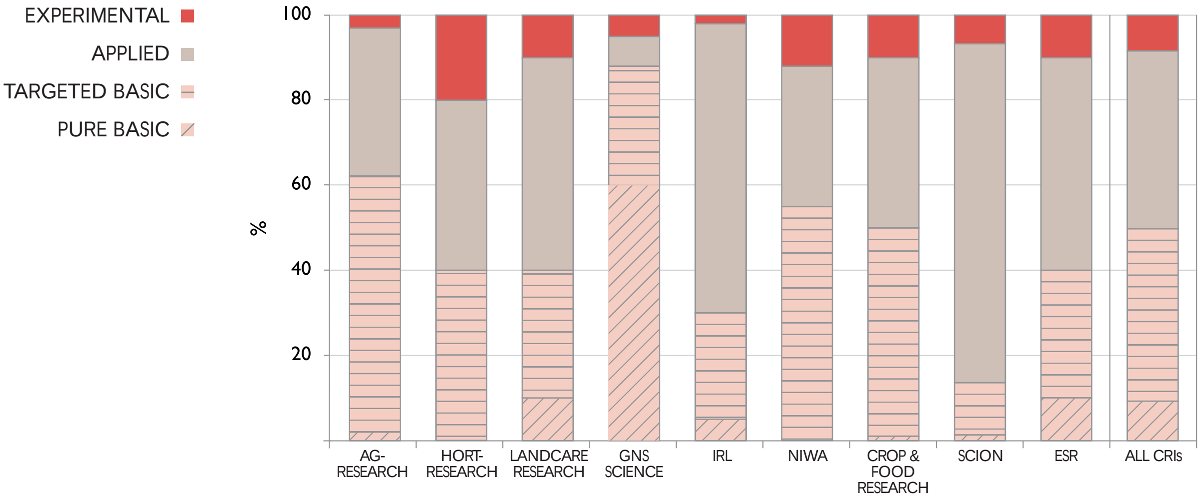


TABLE 5.3 TYPE OF RESEARCH PERFORMED BY CRIs, 2004

TYPE OF RESEARCH	Expenditure 2004 ($M)	Expenditure 2004 (%)
Pure basic	36.3	9
Targeted basic	159.8	41
Applied	164.7	42
Experimental development	33.0	8
TOTAL	393.8	100

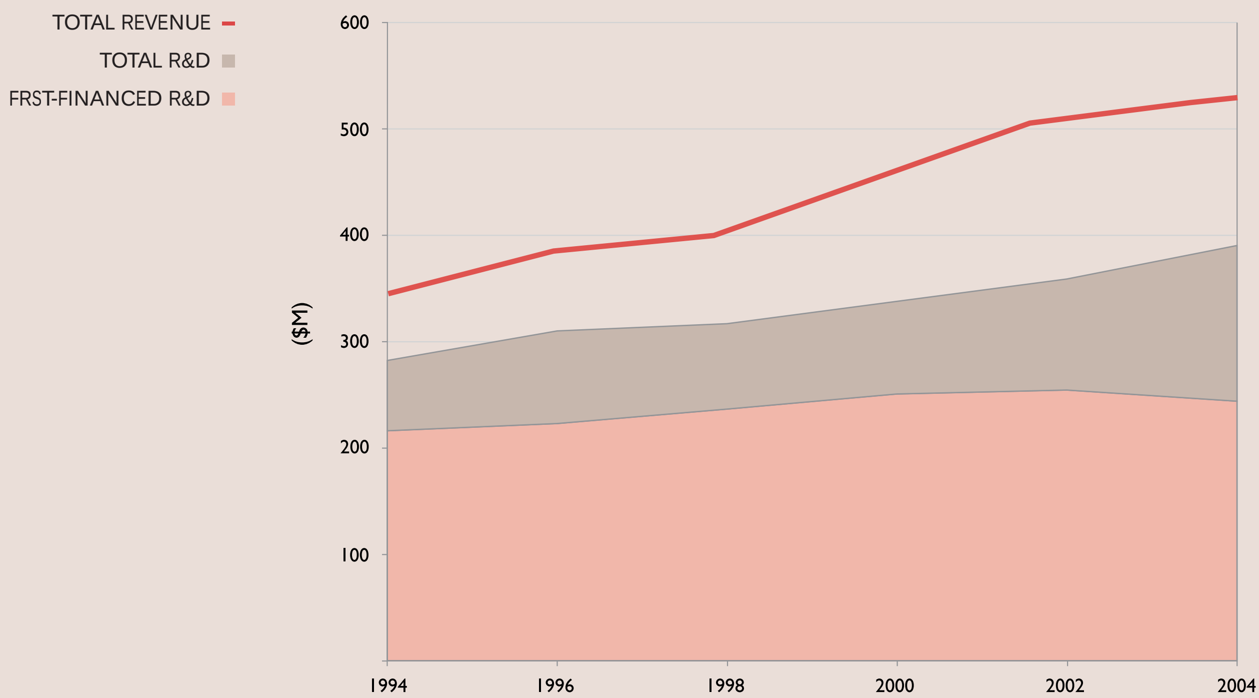
SCIENCE AND TECHNOLOGY ACTIVITIES OF CRIs

In addition to performing the amount and types of R&D detailed in this Chapter, CRIs also perform a range of other scientific activities that fall outside the OECD definition of R&D. These include the following:

- fish stock assessment;
- forensic work;
- seismic monitoring;
- climate monitoring;
- measurement standards; and
- biosecurity services.

CRIs had total revenue of approximately $535 million in 2003/04. Of this, approximately $390 million was Frascati R&D, with the remainder of expenditure on other science and technology functions.

CRI EXPENDITURE ON R&D, FRST FINANCING AND TOTAL REVENUE, 1994–2004



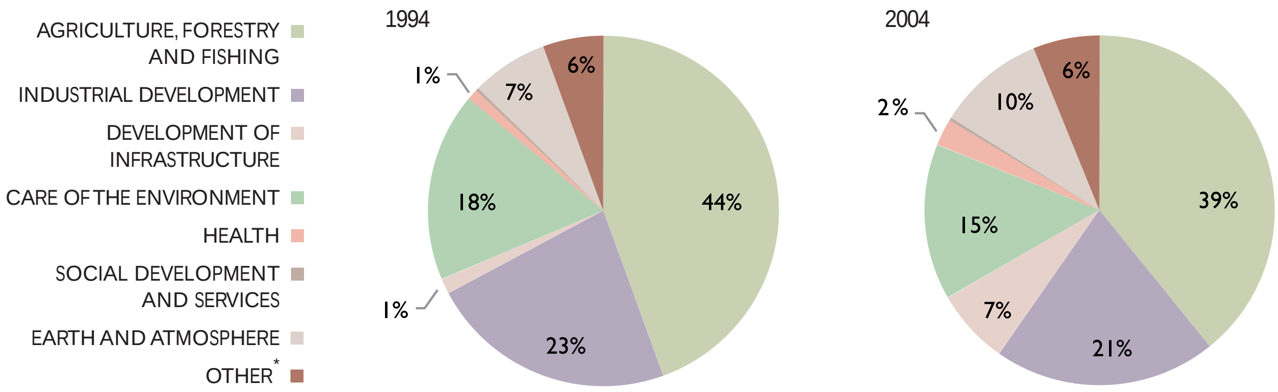
PURPOSE OF RESEARCH

Looking at the research performed in 2004 by all CRIs on the basis of socio-economic objective (or the purpose of the research), the objectives where the majority of R&D was performed were:

- **agriculture, forestry and fishing** (39 percent);
- **industrial development** (21 percent); and
- **care of the environment** (15 percent).

The results for 2004 are shown in Chart 5.7. After allowing for the differences between the classifications adopted between the two years, the results are not greatly different from those recorded in 1994.

CHART 5.7 CRI SECTOR R&D, BY SOCIO-ECONOMIC OBJECTIVE, 1994 AND 2004



* Includes energy, defence, space, and knowledge general. See text box on page 23 for further definition of these categories.

RESEARCH SPECIALISATION

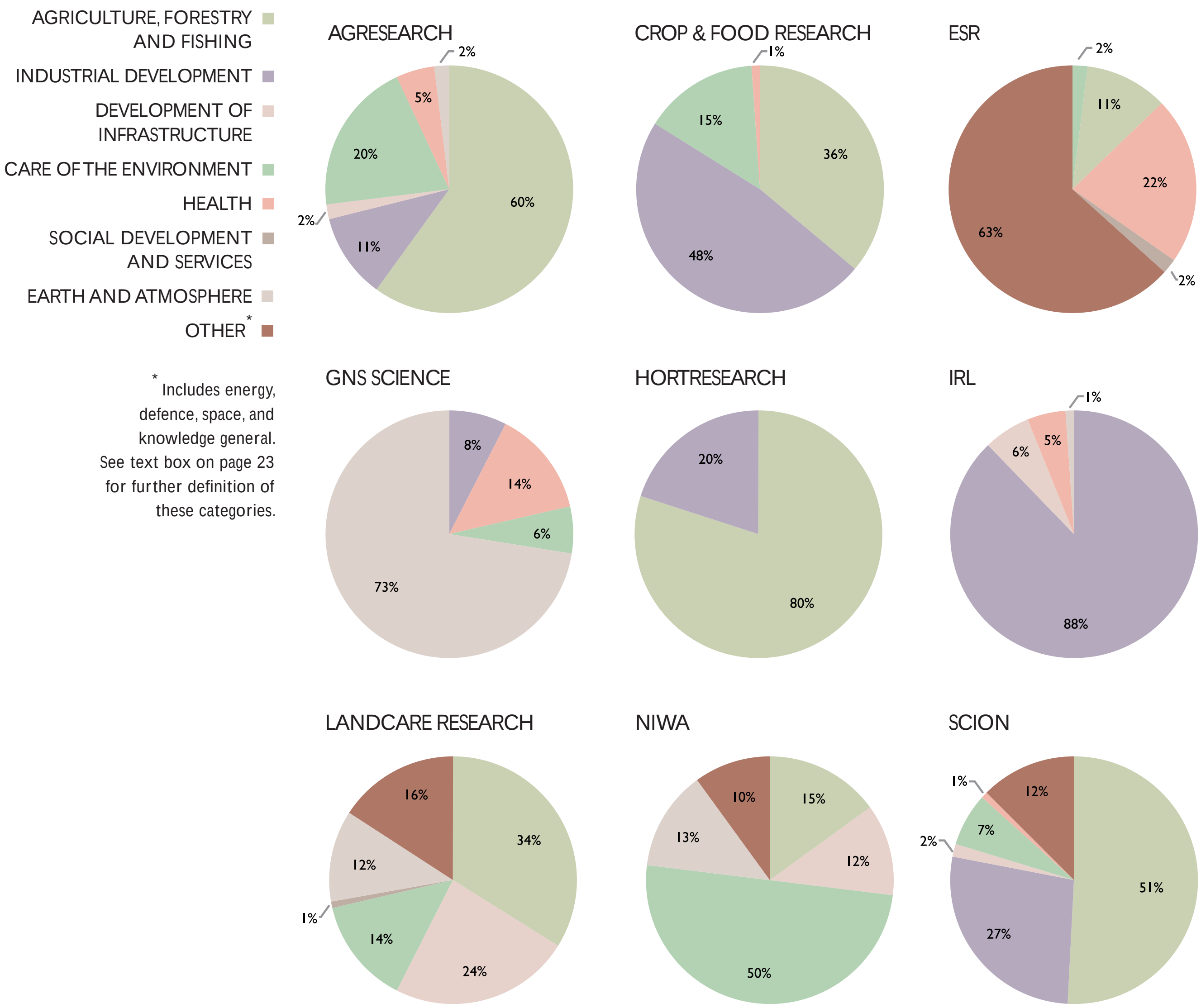
Using the data reported by individual CRIs, it is possible to look at the spread across CRIs of R&D carried out in the various socio-economic objectives. Chart 5.8 shows the purpose of R&D performed by individual CRIs in 2004.

The key points arising from this presentation shown in Chart 5.8 are that:

- R&D into **agriculture, forestry and fishing** is the largest socio-economic objective for AgResearch, Scion, HortResearch and Landcare Research. It should be noted that each of these CRIs may undertake research into very different aspects of the **agriculture, forestry and fishing** socio-economic objective;
- R&D into **industrial development** is the largest socio-economic objective for IRL and Crop & Food Research;
- R&D into the **development of infrastructure** forms a substantial contribution for Landcare Research, GNS Science and NIWA;
- R&D into the **care of the environment** forms half of R&D performed at NIWA and is also important for AgResearch, Landcare Research, Crop & Food Research and ESR;
- R&D into **health** is a minor socio-economic objective amongst most CRIs with the exception of ESR; and
- R&D into **earth & atmosphere** is a major socio-economic objective for GNS Science, as well as being important for NIWA and Landcare Research.

CHART 5.8

CRI R&D, BY SOCIO-ECONOMIC OBJECTIVE, 2004



* Includes energy, defence, space, and knowledge general. See text box on page 23 for further definition of these categories.

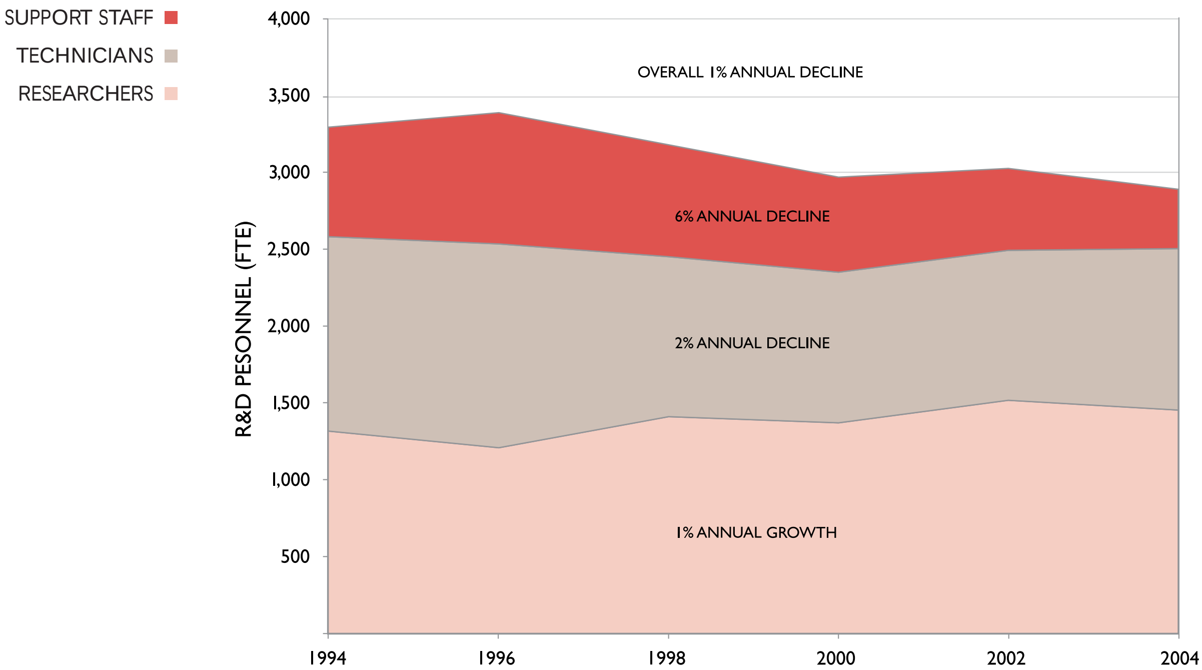
HUMAN RESOURCES SPENT ON R&D

There were some 2,890 staff years of effort devoted to research at CRIs in 2004. As shown in Chart 5.9. the research effort was provided by:

- **researchers**, who contributed 50 percent of the research effort;
- **technicians**, with 36 percent; and
- **support staff**, with 13 percent.

CHART 5.9

CRI R&D PERSONNEL, BY TYPE OF PERSONNEL, 1994–2004



Since 1994, R&D FTEs in CRIs have decreased by 12 percent, which represents an average annual decrease of about one percent per annum. Whilst total expenditure on R&D by CRIs over this period has increased by 39 percent, expenditure on **wages and salaries** has remained fairly constant (see Chart 5.4).

The drop in total FTE research effort masks some significant changes in the occupational distribution of research in CRIs. The input by **researchers** is the only occupational category to have increased, while the input by **technicians** and **support staff** has declined. The change in the full-time equivalent research effort is as follows:

- for **researchers** – increased by 10 percent;
- for **technicians** – decreased by 17 percent; and
- for **support staff** – decreased by 46 percent.

Table 5.4 shows the time series of data for the occupations identified above, from 1994 to 2004.

TABLE 5.4

CRI R&D PERSONNEL, BY TYPE OF PERSONNEL, 1994 AND 2004

PERSONNEL TYPE	1994	2004
Researchers	1,316	1,453
Technicians	1,266	1,050
Support staff	713	387
TOTAL R&D PERSONNEL	3,295	2,890

R&D INTENSITY IN CRIs

It is possible to develop a measure of the research intensity of CRIs in total, based on their human resource input into R&D as reported in the R&D survey, and their total staff effort as reported in the annual reports of each of the CRIs.

This analysis shows that the share of R&D staff to total workforce in 2004 was 61 percent. By way of comparison, the research intensity for the University sector was 26 percent[1].

[1] Excludes post-graduate research effort – this would be 47 percent if post-graduates were included.

Chart 5.10 shows the R&D intensity of each of the CRIs individually. From this chart, it becomes apparent that ESR and NIWA had comparatively low intensities. GNS Science had the highest intensity of 90 percent.

CHART 5.10

RESEARCH INTENSITY, BY CRI, 2004

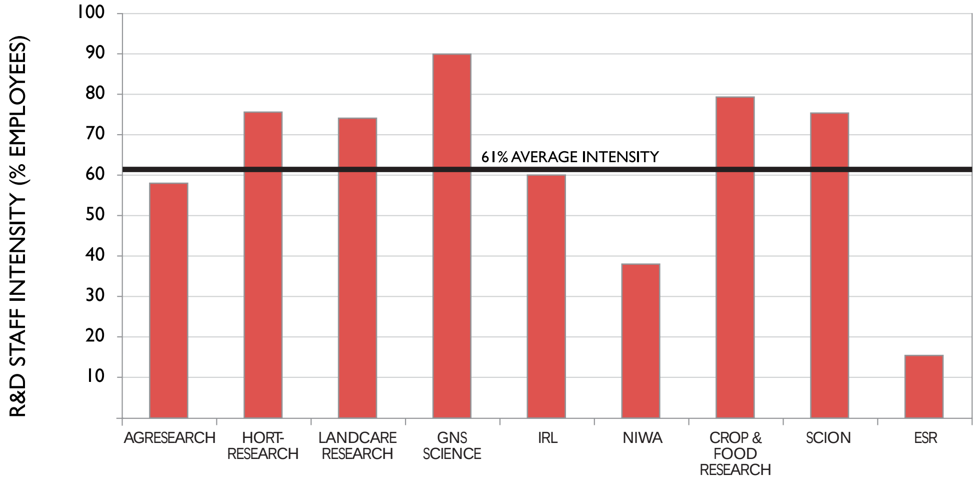
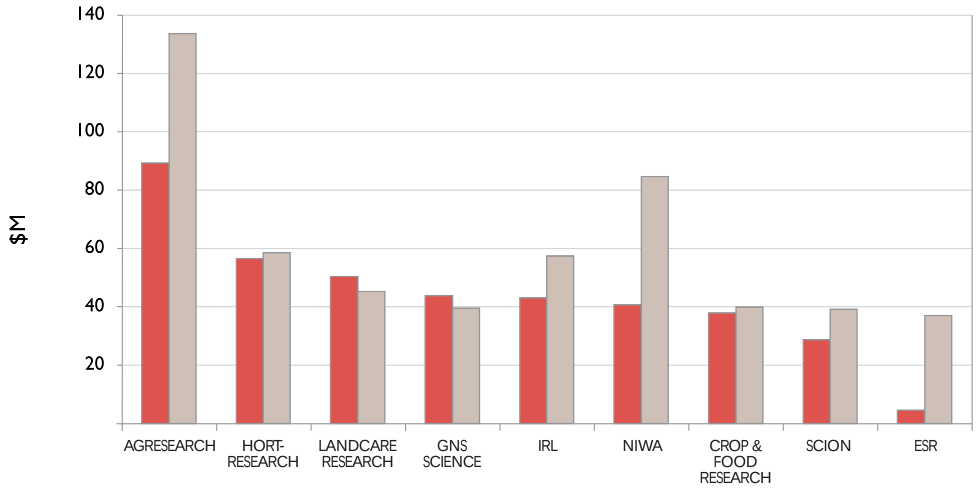


Chart 5.11 shows R&D expenditure together with total revenue. This shows that AgResearch, NIWA and ESR conduct large amounts of non-Frascati research and consultancy services in addition to R&D. ESR in particular shows a focus on its forensic and consultancy work and performs a significantly lower proportion of R&D than the other CRIs.

CHART 5.11

EXPENDITURE ON R&D AND TOTAL REVENUE, BY CRI, 2004

R&D EXPENDITURE
TOTAL REVENUE



NOTE: Some CRIs have reported more R&D expenditure than total revenue in a single year. This reflects multi-year R&D projects and accounting practises for capital expenditure.

6 GOVERNMENT FINANCING OF R&D

MAIN FINDINGS

- For the 2005/06 financial year, government departments and agencies budgeted $791 million for Frascati R&D activities.
- Ninety-three percent of government funding for R&D comes through Vote RS&T (68 percent) and Vote Education (26 percent).
- Other government departments and agencies (including local government) contribute a further six percent ($51 million) of all Frascati R&D funded by government.
- Government is also a major funder of operational research, including routine monitoring and data collection.
- A further $94 million of routine data collection, monitoring and operational research is funded by the government sector.
- Key agencies funding non-Frascati research are the Ministry of Fisheries and the Ministry of Agriculture and Forestry (MAF).
- Vote RS&T also funds a further $32 million for supporting scientists, funding collaboration and science promotion activities.
- Vote RS&T has increased 50 percent over the past five years, with total research funding (excluding capital and administration) increasing 41 percent since 2001/02.

INTRODUCTION

The government is a major contributor of funding for R&D in New Zealand; 45 percent of all R&D performed in New Zealand is financed by government (including local government). A further seven percent of R&D is financed by universities' own funds - traditionally not included in published figures of government financing (and not further considered in this chapter).

The government agencies that are the biggest funders and investors in RS&T are primarily Crown entities. Crown entities are a diverse group of organisations that typically have an arm's length relationship with Ministers and a role that is more tightly defined, often by statute, than a department or Ministry.

Ninety-three percent of government funding for R&D comes through Votes RS&T (68 percent) and Education (26 percent). The government sector contracts out the majority of its research to CRIs, universities, and the private sector, and therefore performs very little R&D in-house.

In addition to the financing streams considered in this analysis, CRIs also fund R&D from their own funds. As Crown entity companies, this amount is included in national estimates of total Government financing of R&D. In 2004 this amounted to $30 million.

OTHER GOVERNMENT-FINANCED R&D[1]

[1] Excluding Votes RS&T and Education

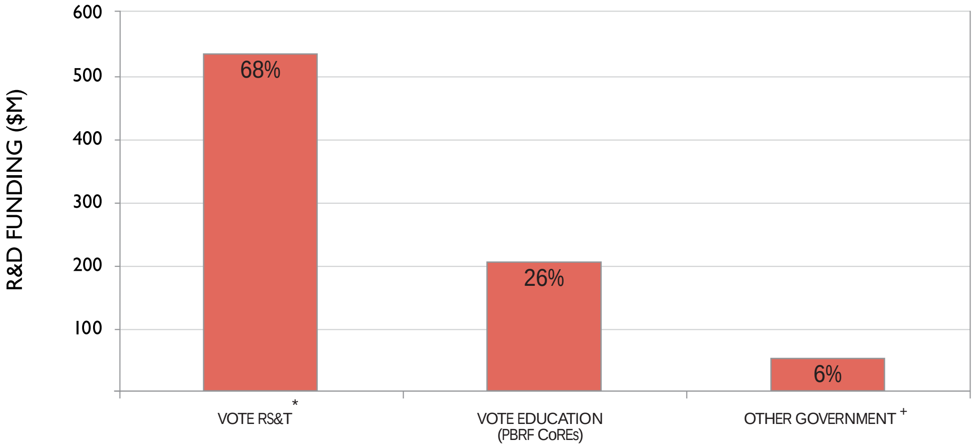
Previous R&D survey results showed a large degree of variability in the level of R&D reported by the government sector. This is possibly due to confusion regarding the type of research funded, and alignment with the Frascati definition of R&D.

In May 2005 MoRST conducted a survey of the (non-CRI) government sector to better understand the type and quantity of research funded and performed by the government sector. The data presented in this chapter is a forward-looking estimate of anticipated research expenditure for the 2005/06 financial year.

For the 2005/06 financial year, government departments and agencies budgeted $791 million for Frascati R&D activities. As can be seen in Chart 6.1, 68 percent of all R&D funded by the government sector comes from Vote RS&T.

A further 26 percent is funded through Vote Education and is only available to the higher education sector. Other government departments and agencies (including local government) fund six percent ($51 million) of all Frascati R&D funded by government.

CHART 6.1 TOTAL GOVERNMENT FUNDING OF R&D, 2005/06 (FORECAST)



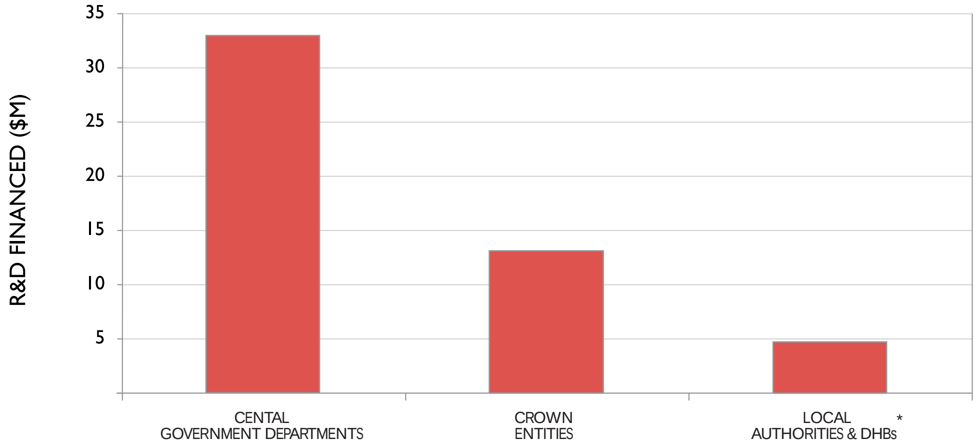
* Does not include non-Frascati science funding, capital expenditure or research contract management.

+ See Chart 6.2 for a breakdown of other government.

Other government agencies fund $51 million of R&D, the bulk of this coming from central government departments.

CHART 6.2

OTHER GOVERNMENT-FINANCED R&D, BY SECTOR, 2005/06 (EXCLUDES VOTES RS&T AND EDUCATION)



* District Health Boards.

Top funders outside of Votes RS&T and Education are MAF, DoC, Land Transport New Zealand, New Zealand Defence Force and the Accident Compensation Corporation (ACC).

TABLE 6.1

TOP 10 GOVERNMENT SECTOR FUNDERS OF R&D 2005/06*

NAME	Total financed ($M)	Total financed (%)
Vote RS&T+	535.0	67.7
Vote Education^x	205.0	25.9
MAF	20.0	2.5
DoC	5.9	0.7
Land Transport New Zealand	4.2	0.5
New Zealand Defence Force	4.1	0.5
ACC	3.0	0.4
Environment Canterbury	2.1	0.3
Earthquake Commission	1.9	0.2
Museum of New Zealand Te Papa Tongarewa	1.6	0.2
Remaining Government sector	8.0	1.0
TOTAL	790.8	100.0

* Budget estimates for 2005/06.

+ Vote RS&T is administered by MoRST and FRST, the Health Research Council (HRC) and the Royal Society of New Zealand (RSNZ).

x Vote Education is only available to tertiary education organisations and includes the Performance-Based Research Fund and Centres of Research Excellence.

In addition to the $535 million of Vote RS&T allocated towards R&D, some $32 million is allocated to supporting scientists and the science system more widely, through outcomes such as Supporting Promising Individuals, Promoting an Innovation Culture and Development of International Linkages, as well as National Measurement Standards and Pre-seed Accelerator Fund.

NON-FRASCATI RESEARCH

The government funds a spectrum of science and research, only some of which can be defined as Frascati R&D. Government is also a major funder of operational research, including routine monitoring and data collection.

A further $94.2 million of routine data collection, monitoring and operational research is funded by the government sector. This work includes scientific monitoring and is for operational purposes.

Key agencies funding non-Frascati Research are the Ministry of Fisheries and MAF.

TABLE 6.2 TOP 10 FUNDERS OF NON-FRASCATI MONITORING AND DATA COLLECTION, 2005/06*

NAME	Amount Financed ($M)	Amount Financed (%)
Ministry of Fisheries	25.8	27
MAF	22.6	24
Earthquake Commission	8.4	9
MED	7.7	8
Environment Canterbury	4.1	4
Ministry of Health	3.3	4
Environment Bay of Plenty	2.7	3
Otago Regional Council	2.6	3
Hawke's Bay Regional Council	2.3	2
Auckland Museum Trust Board	1.9	2
Remaining Government sector	12.8	14
TOTAL	94.2	100

* Budget estimates for 2005/06.

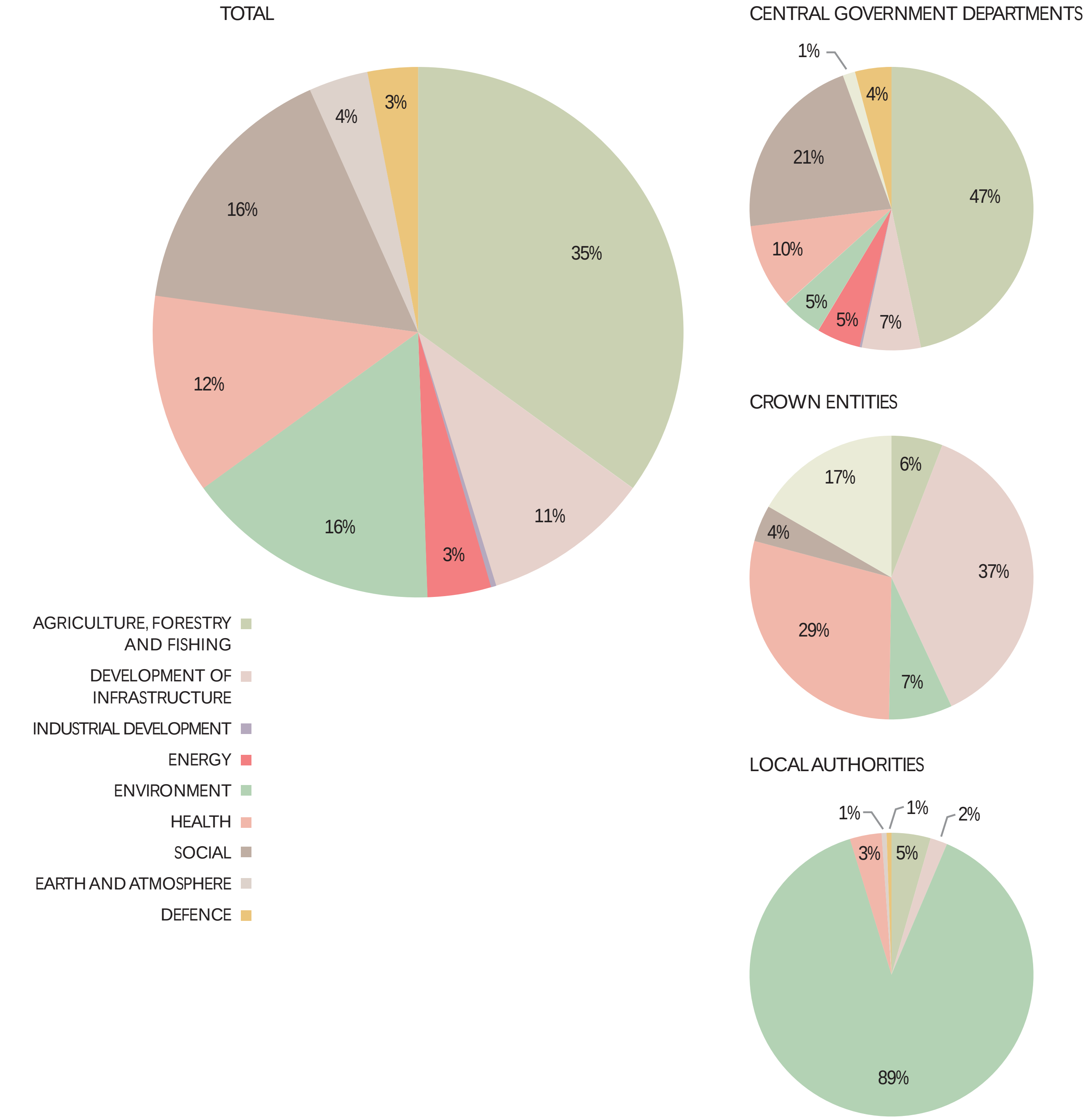
SOCIO-ECONOMIC OBJECTIVE OF RESEARCH FUNDED BY GOVERNMENT

The largest socio-economic objective funded by government was **agriculture, forestry and fishing**. Local authorities funded the largest proportion of research aimed at **care for the environment**. The large impact of research funded by MAF and the Ministry of Fisheries is seen in the central government department chart. A large proportion of **health** research is funded by the Accident Compensation Corporation (a crown entity).

CHART 6.3

SOCIO-ECONOMIC OBJECTIVE OF RESEARCH* FUNDED, 2005/06
(EXCLUDES VOTES RS&T AND EDUCATION)

*Includes routine data collection, monitoring and operational reasearch.



NOTE: See text box in Chapter 2, page 23 for further definition of these categories.

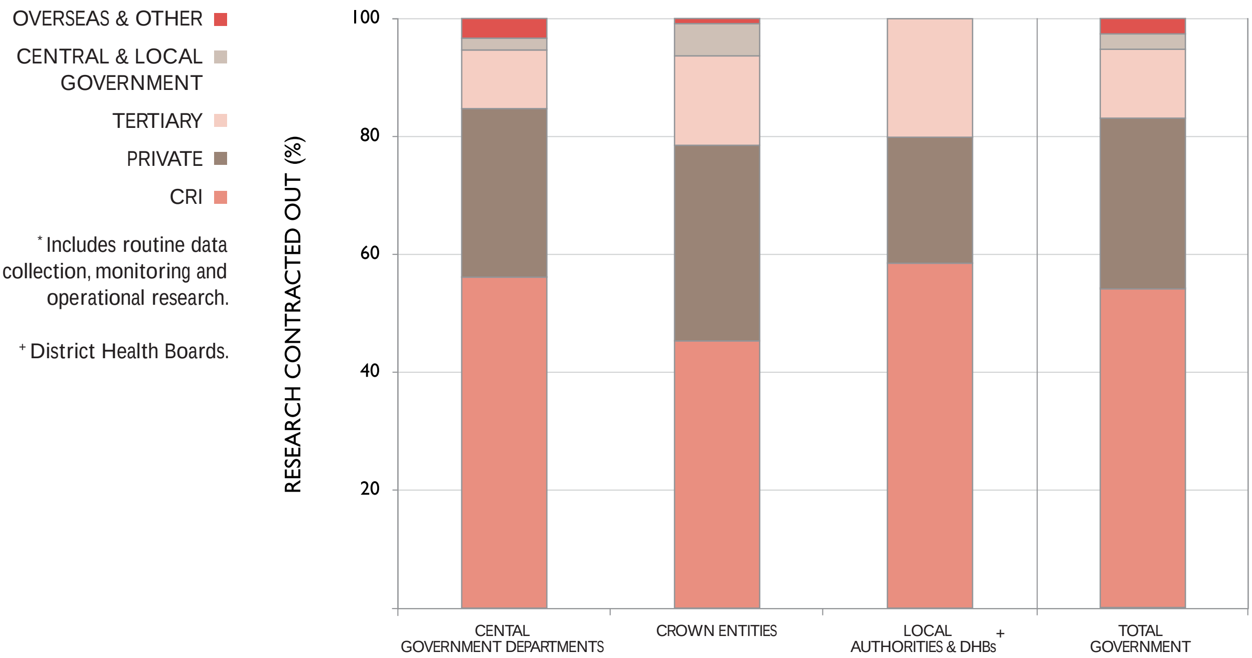
WHO PERFORMS RESEARCH FUNDED BY GOVERNMENT

The majority of research funded by central government departments and Crown entities is contracted out to third party providers, while local authorities tend to conduct the majority of research they finance in-house.

By far the largest providers are the CRIs, receiving over half of all research contracted out. Local authorities contract out the highest proportion of their external research to CRIs, while Crown entities are the heaviest users of the private sector.

CHART 6.4

PROPORTION OF RESEARCH* CONTRACTED OUT BY PROVIDER TYPE, BY SECTOR, 2005/06 (EXCLUDES VOTES RS&T AND EDUCATION)



* Includes routine data collection, monitoring and operational research.

\+ District Health Boards.

Local authorities conduct 64 percent of research in-house. This is primarily routine data collection and monitoring functions.

ALLOCATING GOVERNMENT FUNDING

A number of Crown entities are responsible for allocating, distributing and investing public sector funds.

FOUNDATION FOR RESEARCH, SCIENCE AND TECHNOLOGY

FRST is the government's primary agency for allocating funds for public good science and technology. FRST allocates around half of the government's investment in RS&T in accordance with government priorities set down by the Minister of RS&T. FRST is the biggest single funder of research in New Zealand and has funding relationships with virtually every type of research organisation.

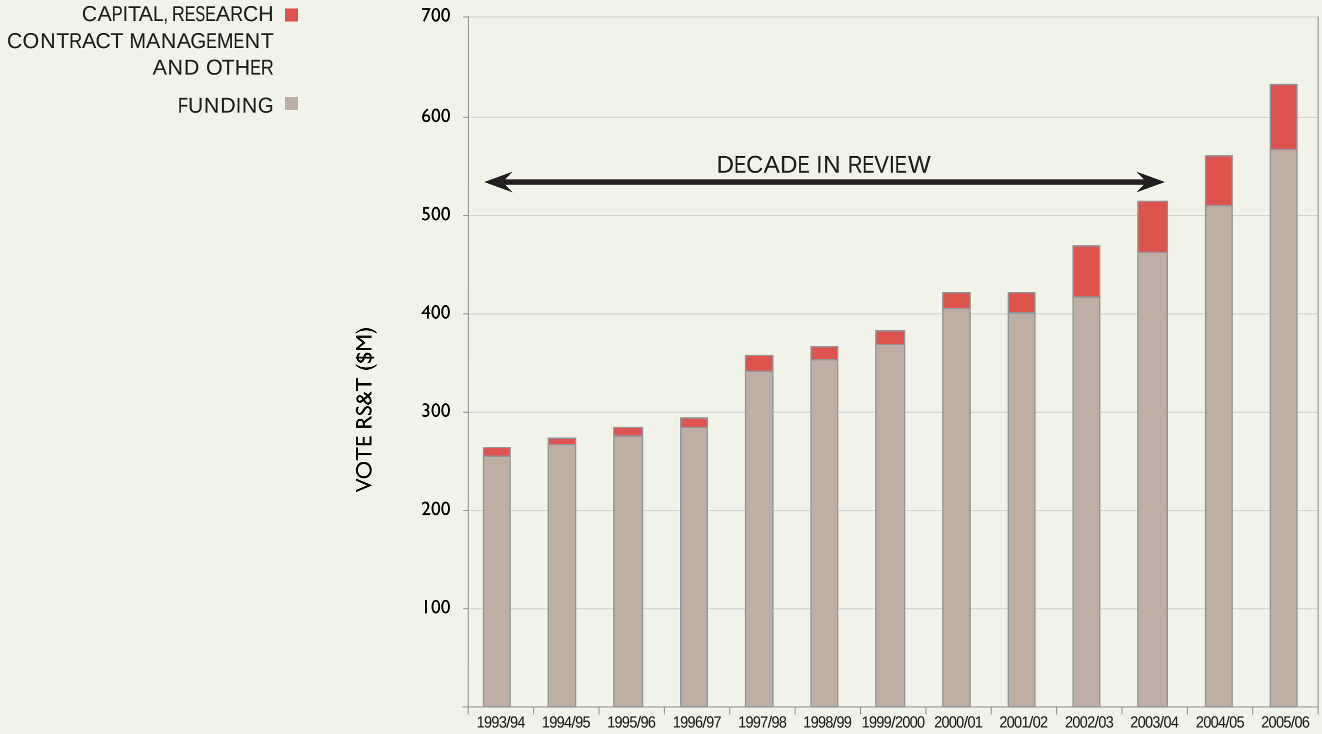
FRST also provides the Minister with independent policy advice on matters relating to research, science and technology, including advice on research needs and priorities.

FRST's primary responsibility is to allocate funds on behalf of the Minister of RS&T. The Estimates of Appropriations (the Budget) set out the funds allocated through FRST and define their purpose.

VOTE RS&T

CRIs receive over half of the funding allocated through Vote RS&T. Recent years have seen an increase in the share of funding allocated to the private sector and universities.

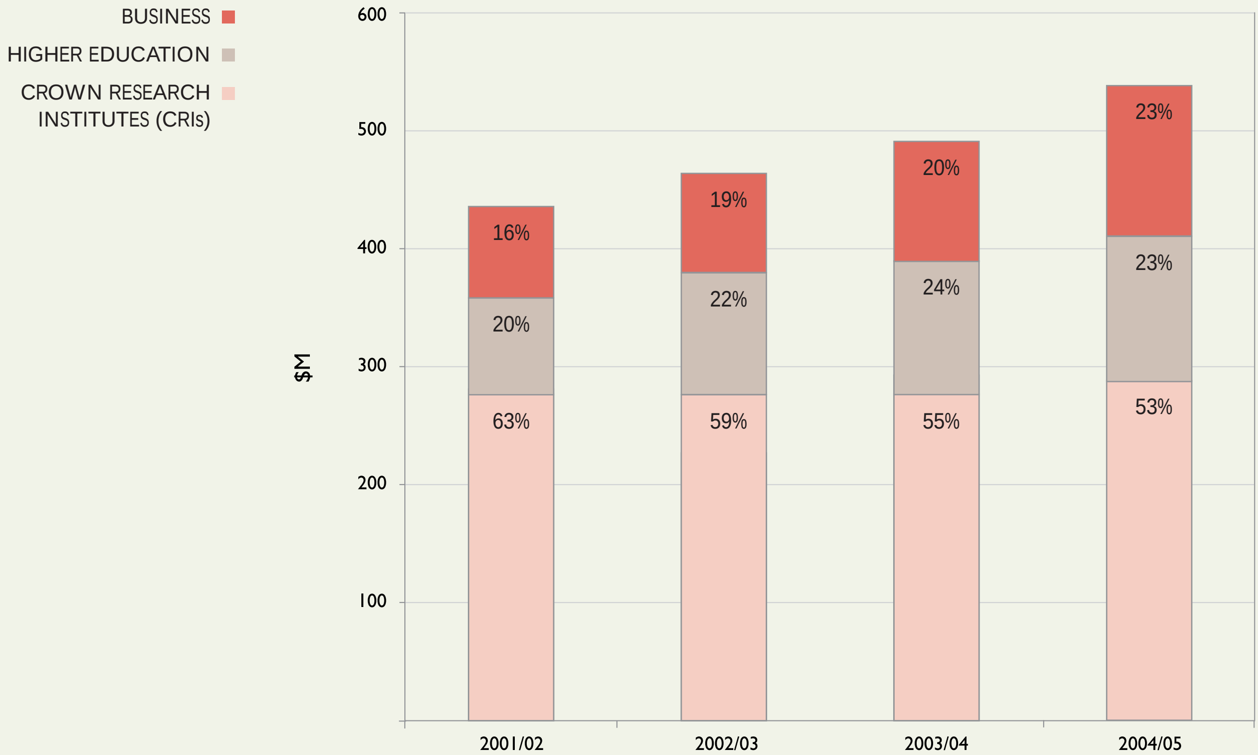
VOTE RS&T OVER TIME



Vote RS&T has increased 50 percent over the past five years, with total research funding (excluding capital and administration) increasing 41 percent since 2001/02.

VOTE RS&T ALLOCATED BY RESEARCH PROVIDER

SOURCE: FRST, HRC & RSNZ



NOTE: Percentages show overall provider share per year, net of sub-contracting.

HEALTH RESEARCH COUNCIL OF NEW ZEALAND

The HRC is the main funder of health research in this country and also awards a range of scholarships and fellowships. The research it funds supports a range of investigator-initiated research, including basic biomedical, clinical, public health and health services research, as well as research in targeted priority areas such as cancer control and Pacific people's health. The HRC also advises the Minister of Health on national health research policy and maintains the Health Research Council Ethics Committee and its functions.

HRC's primary responsibilities are to allocate funds on behalf of the Minister of RS&T and to advise the Minister of Health on health research priorities. The Estimates of Appropriations set out what the funds allocated through HRC can be spent on.

TERTIARY EDUCATION COMMISSION

The TEC funds research through a number of mechanisms within Vote Education, including the Performance-Based Research Fund (PBRF) and the Centres of Research Excellence (CoRE) programme. These funding mechanisms focus on supporting research excellence and areas of strategic capability, and underpin high quality and relevant teaching and training of students within the tertiary education sector.

The allocation of PBRF to the institutions by TEC is made as a bulk grant. The allocation of this funding within the institutions to research teams and projects is made by the institutions themselves (see Chapter 4 – University R&D)

OTHER GOVERNMENT AGENCIES

The New Zealand Venture Investment Fund Limited (NZVIF) is a Crown-owned company established under the Companies Act 1993. While not specifically focused on commercialising RS&T, it plays an important role in supporting the government's objectives of improving productivity and innovation. It was incorporated in 2002 and is responsible for implementing the New Zealand government venture capital programme and seed co-investment programme. Amongst other things, NZVIF is responsible for supporting the development and growth of the New Zealand venture capital market, which it does as "Funder of Funds". NZVIF is responsible for investing NZ$100 million alongside private sector co-investors in a series of privately managed venture capital investment funds.

NON-GOVERNMENT AGENCIES

The Royal Society of New Zealand (RSNZ) is an independent, national academy of sciences comprising a federation of some 60 scientific and technological societies as well as individual members. It seeks to promote a critical awareness of science and technology in schools, in industry and in society.

The Society's core funding comes from membership fees, sponsorship and donations. The RSNZ is also contracted by the government to support the communication and promotion of science, support promising individuals, and develop international linkages. In addition, the RSNZ provides administrative support for the Marsden Fund Council (MFC) and administers the Marsden Fund.

The MFC comprises up to 10 eminent researchers spanning a range of disciplines. The MFC makes recommendations to the RSNZ on the investments to be made from the Marsden Fund, which is invested in excellent basic research. The terms of reference the MFC applies to its decision-making are set by the Minister of Research, Science and Technology.

GOVERNMENT STRATEGIES RELEVANT TO RS&T

There are a number of current government strategies or policies that have implications for the type of RS&T that is undertaken in New Zealand. These strategies (the key ones are listed in the box below) contain expectations for RS&T to contribute to goals important to New Zealand, such as protecting our biodiversity or managing natural hazards. The RS&T needed for strategies can be agreed specifically by Ministers or, more often, are interpreted from strategies by policy or funding agencies which are expected to take account of strategies in their activities and investments. relationships with virtually every type of research organisation.

GOVERNMENT STRATEGIES WITH IMPLICATIONS FOR RS&T

TOPIC	EXISTING STRATEGY OR POLICY (AGENCY RESPONSIBLE)
Biodiversity	Biodiversity Strategy 2000 (DoC)
Biosecurity	Biosecurity Strategy 2003 (Biosecurity NZ, MAF)
Biotechnology	Biotechnology Strategy 2002 (MoRST) Biotechnology Industry Taskforce report (2002)
Climate change	Climate Change Policy (Climate Change Office, Ministry for the Environment – MfE) Government Memorandum of Understanding with agricultural sector on greenhouse gas mitigation research in agriculture 2004 (MfE)
Energy	Sustainable Development Programme of Action: Sustainable Energy, 2003 (MED) National Energy Efficiency and Conservation Strategy 2001 (Energy Efficiency and Conservation Authority – ECCA)
Health	Health Strategy 2000 and Primary Health Care Strategy 2002 (Ministry of Health)
Information and communication technology	ICT Industry Taskforce report 2003 (MED) Digital Strategy 2005 (MED) e-government strategy 2003 (State Services Commission – SSC)
Natural Hazards	National Civil Defence Emergency Management Strategy 2003-2006 (Ministry of Civil Defence and Emergency Management – MCDEM)
Ocean	Ocean Survey 20/20 2005 (Land Information New Zealand – LINZ) Oceans Policy (MfE)
Social	NZ Positive Ageing Strategy 2001 (Ministry of Social Development – MSD) Sustainable Development Programme of Action: Investing in Child and Youth Development 2003 (MSD) Opportunity for All New Zealanders 2004 (MSD) Better Work, Working Better – Labour and Employment Strategy 2005 (Department of Labour)
Sustainable Cities	Sustainable Development Programme of Action: Sustainable Cities (MfE)
Transport	New Zealand Transport Strategy 2002 (Ministry of Transport)
Water	Sustainable Development Programme of Action: Water 2003 (MfE and MAF) Biodiversity Strategy 2000 (Doc)

7 BIOTECHNOLOGY IN NEW ZEALAND

INTRODUCTION

Biotechnology is a key technology that significantly contributes to the New Zealand economy. New Zealand has one of the fastest growing biotech industries in the world – comprising some 53 companies (six public and 47 private), and a further 28 research institutes and eight universities.

Almost half of our biotechnology companies were formed within the last three years. Figures from the New Zealand stock market for these companies over the last three years show a steady increase from around $1.2 billion to approximately $2.1 billion.

The New Zealand biotechnology sector now employs over 2,000 people, of whom approximately 1,500 are employed within the research organisations. In 2004 the total expenditure across all sectors, excluding the universities, was $430 million with a generated income of $675 million. Currently, New Zealand biotechnology companies export to over 60 countries, generating export earnings in 2004 of $108 million, which is predicted to reach $1 billion by 2014.

BIOTECHNOLOGY BY SECTOR

The Statistics New Zealand report (2004) *Biotechnology in New Zealand* indicated that both biotechnology R&D and its applications were almost evenly split between the health and primary sectors. In health, the main applications are in areas defined as 'lifestyle diseases' (eg central nervous system, cardiovascular disease, asthma and diabetes) and foods whose nutritional value is tailored to meet an individual's genetic makeup.

To date, the biomedical companies have been predominantly spun off from leading universities, with at least two appearing on the Australian Stock Exchange during 2005.

BIOTECHNOLOGY R&D

Biotechnology R&D in 2004 was estimated to be $349 million[1] – 25 percent of total R&D expenditure. As can be seen from Chart 7.1, a higher proportion of CRI R&D is biotechnology R&D compared with the private and university sectors.

Within the private sector, the majority of biotechnology R&D is performed within the **scientific research** industry.

[1] As with other R&D data in this publication, this generally excludes performance by firms with fewer than 10 employees. See the Appendix for further details.

CHART 7.1 PROPORTION OF BIOTECHNOLOGY R&D PERFORMED, BY SECTOR, 2004

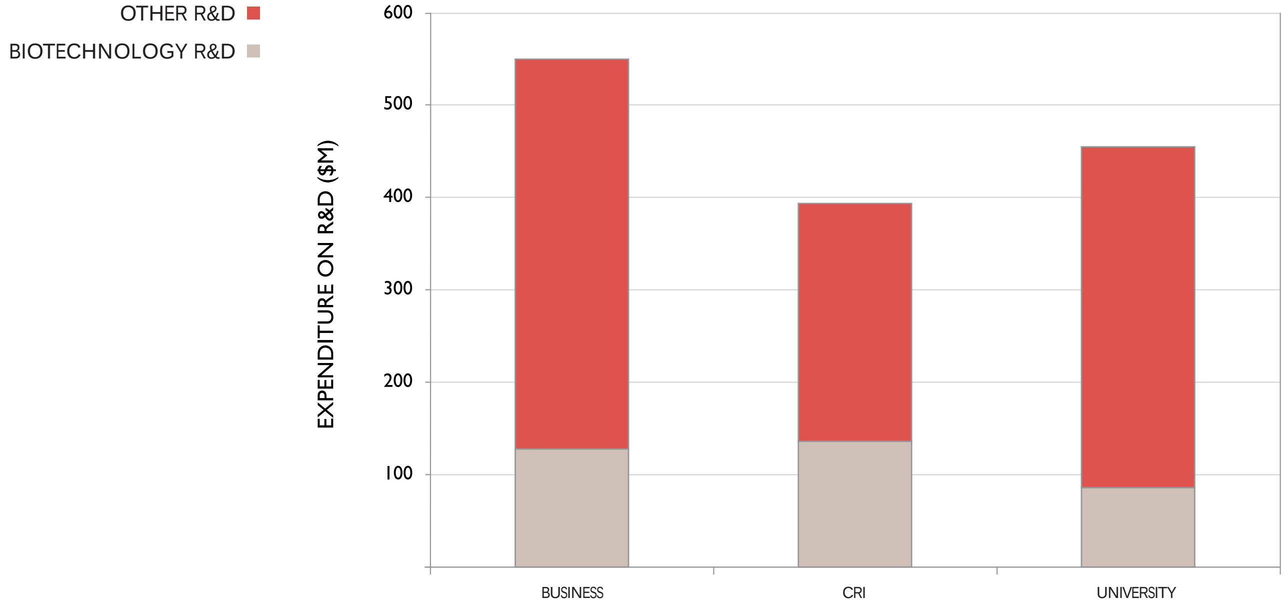


TABLE 7.1 EXPENDITURE ON BIOTECHNOLOGY R&D, 2004

SECTOR	Biotech R&D ($M)	Biotechnology as a proportion of total R&D performed (%)
Business	127.6	23
CRI	135.7	34
University	85.7	19
TOTAL	349.0	25

ECONOMIC CONTRIBUTION WITHIN THE PRIMARY SECTOR

Commercial developments in the primary sector over the last decade have increasingly helped New Zealand industries to stay competitive in a global market. A recent report[2] commissioned by MoRST, and undertaken by the Agribusiness and Economics Research Unit (AERU, Lincoln University), measured the economic contribution of biotechnology to New Zealand's primary sector. The method focused solely on four generic biotechnologies which were commercially used within the different primary industries. This meant that the results were actual values rather than estimates.

[2] The full AERU report is available at www.morst.govt.nz

A summary of the results of the study are shown in the table below, which specifies the four biotechnologies and the relative amounts attributed to each primary industry. The values represent the profits attributed to the biotech-based commercial product over and above the counter factual, ie, what would have been the baseline profits had the biotechnology not been developed. The study also included the sea-food industry, but no commercial products corresponding to the four generic biotechnologies were identified in this section.

TABLE 7.2 SUMMARY OF DIRECT IMPACTS OF THE FOUR GENERIC BIOTECHNOLOGIES

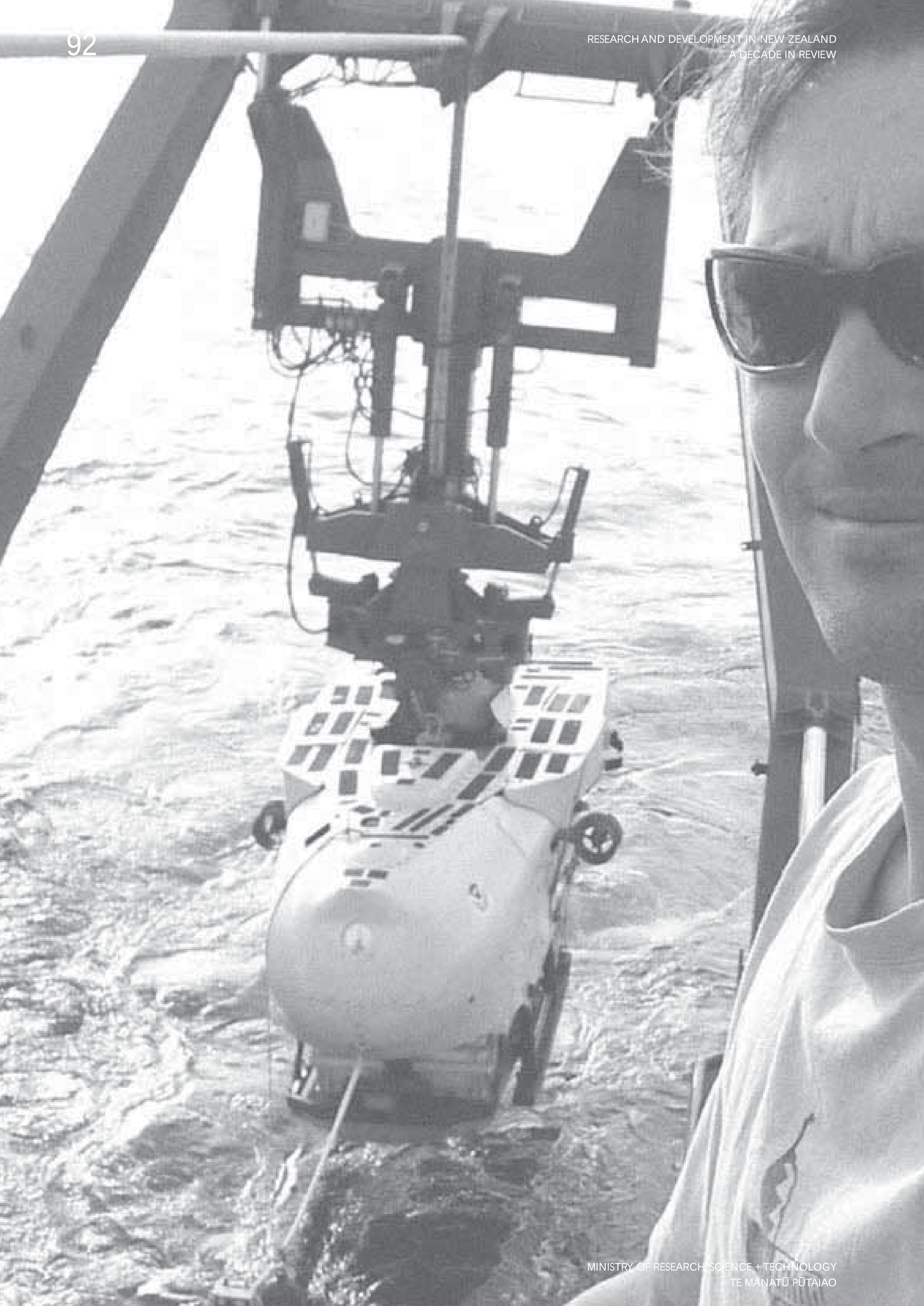
SUB-SECTOR	Clonal propagation, cell manipulation ($M)	Biocontrol agents ($M)	Enzyme manipulations ($M)	Marker-assisted selection ($M)	Total ($M)
Dairy	74.9	19.9	3.8	nil	98.6
Beef and veal	20.9	0.8	nil	nil	21.7
Sheep (meat and wool)	35.3	41.4	nil	0.8	77.4
Forestry	17.0	nil	nil	nil	17.0
Horticulture and floriculture	33.0	small	10.0	nil	43.0
Arable crops	8.2	nil	nil	nil	8.2
TOTAL	189.3	62.0	13.8	0.8	265.8

The results above were fed into the economic models developed by AERU, allowing the wider financial impacts to be considered. The results showed that the annual economic contribution of the four biotechnologies alone was conservatively estimated to be between $300 million and $400 million.

KEY FINDINGS OF THE AERU REPORT

A key finding of the research was that commercialisation of biotech R&D typically took in excess of 10 years. The 'nil' values in Table 7.2 are an indication therefore that the R&D in these areas had not yet reached maturity. The feeling is that these areas should produce a considerable return over the next few years.

By placing the AERU results in the context of the report that focuses on only four biotechnologies, and considering that the primary sector makes up only half of the biotech research and applications in New Zealand, it can be construed that the annual contribution of biotechnology to the New Zealand economy as a whole should be at least double that in Table 7.2.



8

PEOPLE IN SCIENCE AND TECHNOLOGY

MAIN FINDINGS

- Between 1996 and 2001, the number of people with university qualifications in New Zealand grew by 68,000 – this equates to 30 percent growth over the period, an average annual growth rate of about 5.5 percent.
- The driving force behind this growth rate was the number of graduates coming out of the university system. The number of new Bachelor-level graduates between 1996 and 2000 was 88,000.
- The numbers of university qualified males and females in 2001 were almost identical. However, there is a marked difference in the growth rates between genders over the period 1996 to 2000 – 18 percent for males and 45 percent for females.
- Europeans are the largest ethnic group, making up 80 percent of the tertiary-qualified population.
- **Social sciences** was the most significant field of university study. The other most popular fields were **natural sciences, humanities, medical sciences**, and **engineering and technology**.
- The most rapidly growing fields of study between 1996 and 2001 were **medical sciences** and **humanities**.
- Wellington, Auckland and Otago were the regions with the greatest concentration of university-qualified people compared with the population – 16 percent, 13 percent and 11 percent respectively.
- People with university-qualifications were more likely to be employed than the general population, 81 percent compared with 60 percent.
- Thirty percent of the university-qualified people in 2001 were born overseas.

Credit: GNS Science
GNS Science environmental microbiologist Matthew Stott watches as the Pisces V submersible is launched during the 2005 Ring of Fire expedition to explore submarine volcanoes along the Kermadec Arc.

INTRODUCTION

One of the indicators that is frequently used to measure R&D performance is to estimate the amount of human resources devoted to that activity. R&D survey data shows that more than 70 percent of the R&D effort is provided by researchers, practically all of whom have tertiary qualifications.

These statistics highlight the importance of people with tertiary qualifications to the research effort in New Zealand. It is therefore important to study this group of people in more detail. This chapter is aimed at providing some insights into that group of people.

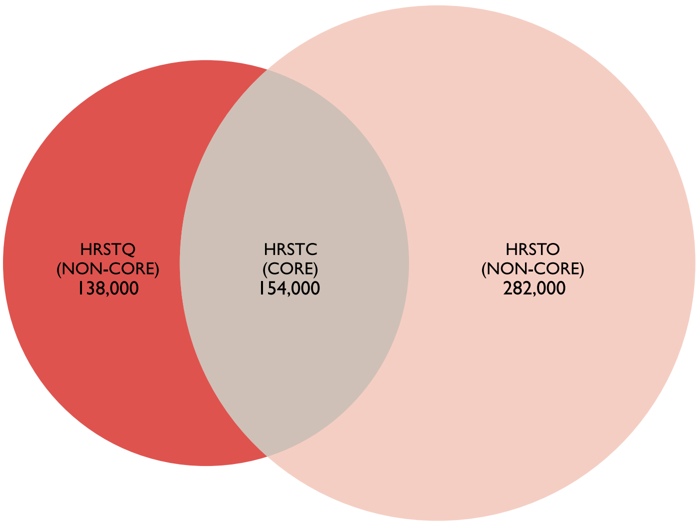
Most international studies of this type are based on the definitions and conventions developed by the OECD. The analysis in this chapter is also based on these conventions. The data for the analysis is taken from the 1996 and 2001 Census data supplied by Statistics New Zealand.

DEFINITIONS

Human resources in science and technology (HRST) is defined by two parameters - qualifications (HRSTQ) and occupations (HRSTO). These represent respectively the supply of people to the science and technology system and the demand for them. Total HRST can then be seen as being the sum of these two categories, with the overlap between them termed the 'core' of HRST or HRSTC. This relationship is shown diagrammatically in Chart 8.1. The chart shows the number of people in each group in 2001[1].

[1] An earlier analysis of the same data, *Human Capital Statistics 2003*, Statistics New Zealand, uses a slightly different approach. For example, it includes technicians and associate professionals. Hence those numbers differ from those presented here.

CHART 8.1 OVERVIEW OF HRST GROUPS, 2001



In this analysis, we concentrate on the supply of qualified HRST, or HRSTQ, at the university level. This is defined as:

> *'those who have completed education at the bachelor or higher level, irrespective of the course content'.*

This is in line with the OECD standard definitions, and as such has a wider scope than the 'scientists and engineers' concept sometimes used in science and technology studies.

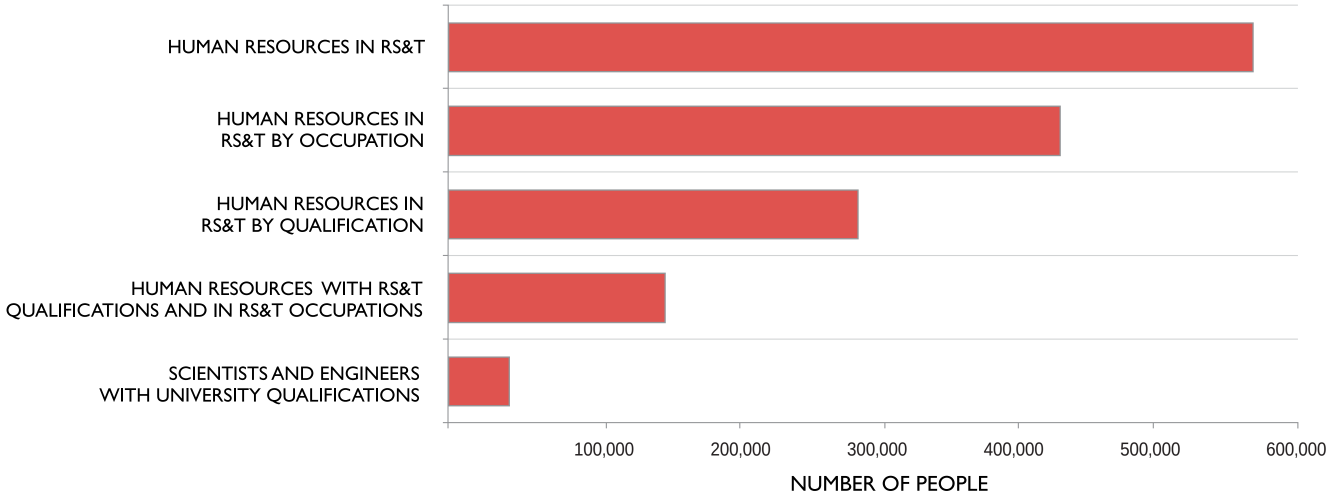
THE SIZE OF UNIVERSITY-LEVEL HRST

Chart 8.2 summarises the HRST stocks in the New Zealand workforce in 2001. As can be seen, the supply of HRST is much smaller than the demand for those people. The supply, HRST defined by qualification, is estimated to be 292,000. The demand for such people, HRST defined by occupation, is estimated to be 436,000 - nearly 50 percent more than the supply[2].

[2] Statistics New Zealand has advised there are some quality issues with the highest qualification data due to under-reporting. See *Human Capital Statistics, 2003*, Statistics New Zealand.

The total number of HRST, people defined by qualification and/or occupation, is 575,000 - about 20 percent of the population aged over 15 years.

CHART 8.2 NEW ZEALAND'S STOCK OF UNIVERSITY LEVEL HRST, 2001



However, the overlap between the categories is small, with only 154,000 people being included in both the supply and demand for HRST – this is the core (see Chart 8.1).

In 2001, of the 292,000 who were qualified, only half were actually employed in HRST occupations, with the remainder either employed in other occupations or not employed at all.

Of the 436,000 employed in HRST occupations, only about one-third were qualified as such.

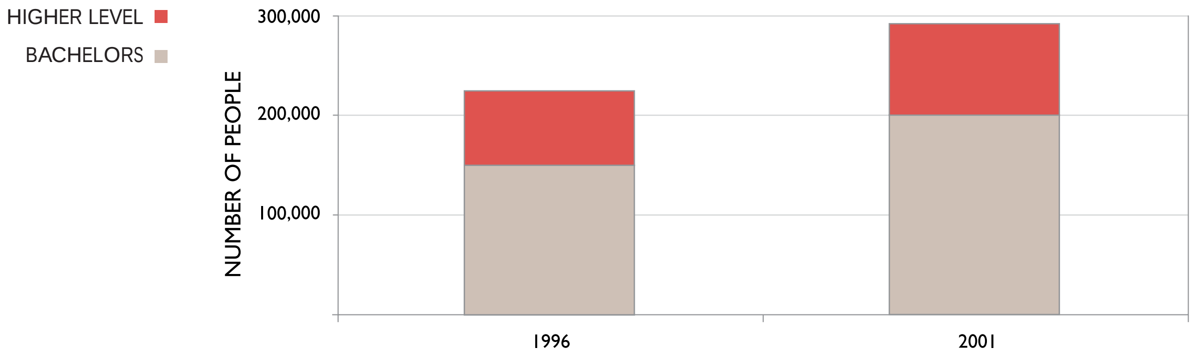
The OECD definition of HRST occupations is relatively broad and includes many occupations not traditionally regarded as scientists or engineers. Restricting the occupations to core science and engineering occupations brings the total to 103,000, of which 43,000 have university level qualifications.

THE SUPPLY OF HRST (HRSTQ)

As can be seen from Chart 8.3 the number of people living in New Zealand in 2001 who had completed a university degree was 292,000. About two-thirds of these held Bachelors degrees, with a third having higher level degrees. Ten percent of the 2001 adult population were university qualified.

In 1996, the number of people who were qualified as HRSTQ was estimated to be 224,000, representing about eight percent of the 1996 adult population. The number has risen quite significantly between 1996 and 2001 - by 68,000 (30 percent). This increase represents two percent of the university qualified adult population (from eight percent to 10 percent).

CHART 8.3 NUMBER OF PEOPLE WITH UNIVERSITY-LEVEL QUALIFICATIONS, 1996 AND 2001



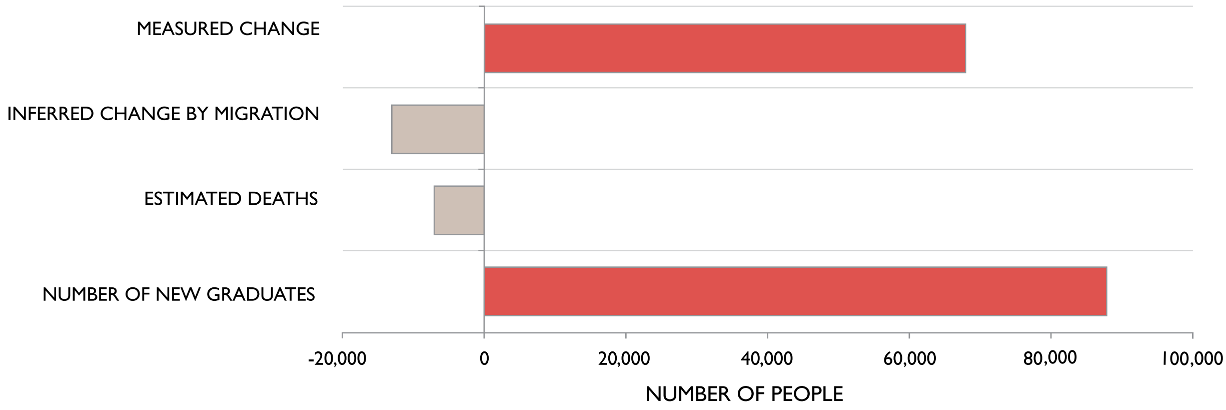
The three main ways in which the number of graduates might change over time are:

- through graduation from universities;
- through death; and
- from net migration flows.

New Zealand universities awarded 88,000 Bachelors degrees between 1996 and 2000[3]. Clearly, new graduates are an important part of the growth in HRSTQ. It is estimated that about 7,000 university-qualified people died in that period. By inference, there has been a decline in the level of HRSTQ in New Zealand as a result of net migration flows of 13,000[4]. This is shown in Chart 8.4 below.

[3] Ministry of Education.
[4] Ignores any possible impact of non-sample error.

CHART 8.4 CHANGES IN UNIVERSITY QUALIFIED PEOPLE, 1996-2001



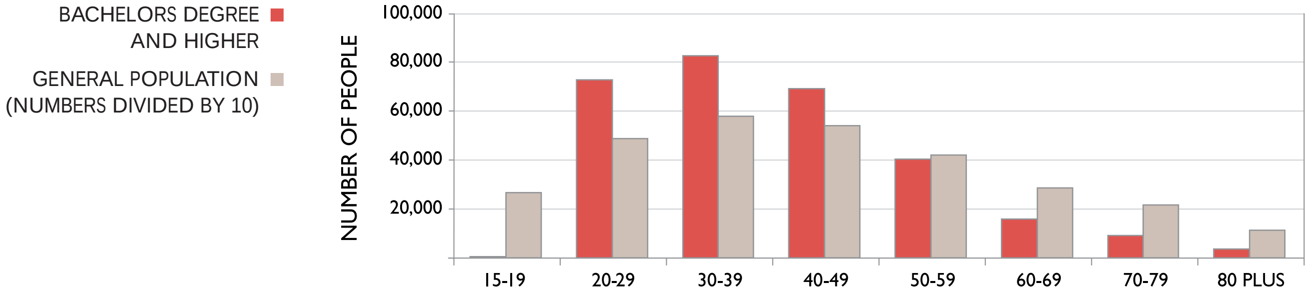
CHARACTERISTICS OF UNIVERSITY-LEVEL HRSTQ

It is useful to analyse the groups of people classified as being in HRSTQ by personal characteristics such as age, gender, ethnicity and country of birth, as well as by field of study.

Chart 8.5 shows the age distribution of HRSTQ. Compared with the age structure for the New Zealand population more generally, it is apparent that the distribution of people with university degrees peaks in the 20 to 50 age range but drops away in older age groups.

CHART 8.5

AGE STRUCTURE OF UNIVERSITY HRSTQ COMPARED WITH THE GENERAL POPULATION, 2001



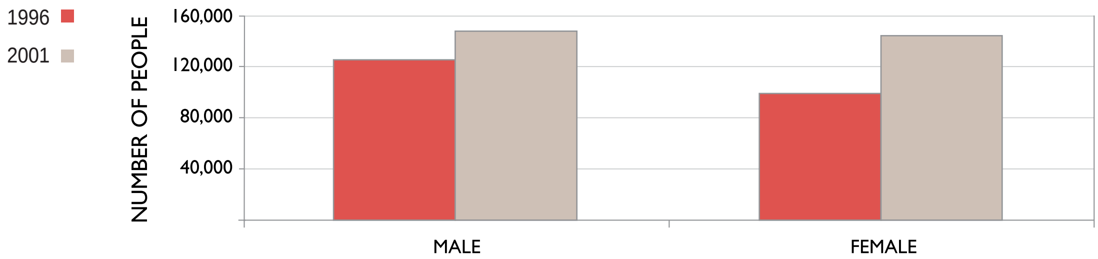
NOTE: The numbers for the total population have been divided by 10 so that the other trends show up against the much larger numbers of the general population.

As shown in Chart 8.6 the number of male and female HRSTQ in 2001 was almost identical. This is markedly different from the distribution that existed in 1996, when there was a significantly higher proportion of males in this category.

The growth rate between 1996 and 2001 was 18 percent for males and 45 percent for females, leading to the overall average of 30 percent. The gender difference in growth rates is consistent with university graduate data available from the Ministry of Education which shows a significantly higher growth in the number of female graduates between the 1996 and 2001 Censuses.

CHART 8.6

GENDER DISTRIBUTION OF UNIVERSITY-LEVEL HRSTQ, 1996 AND 2001

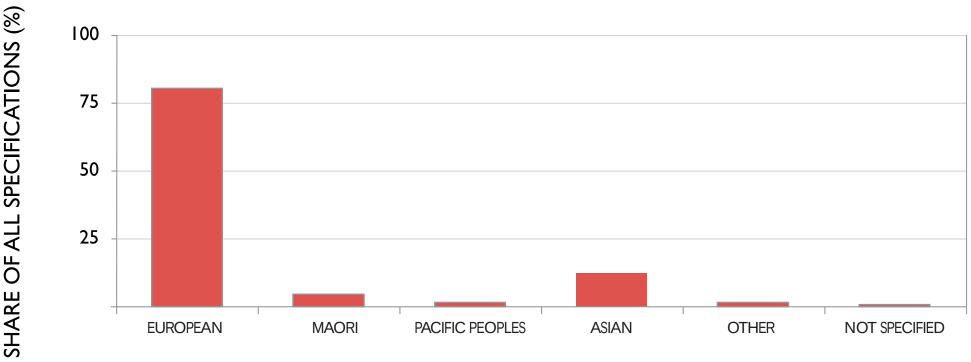


[5] People are able to specify more than one ethnicity. The percentages in the analysis below refer to the total number of specifications (301,000), not the total number of people (292,000).

Chart 8.7 shows the ethnic profile of university-qualified people in 2001[5]. This shows that the vast majority of HRSTQ – about 80 percent – are of European ethnicity. The next largest groups are Asian (12 percent) and Maori (four percent).

CHART 8.7

ETHNICITY PROFILE OF UNIVERSITY-LEVEL HRSTQ, 2001



Within each ethnic group the proportion of university qualified people varies considerably from the 10 percent average for the entire population:

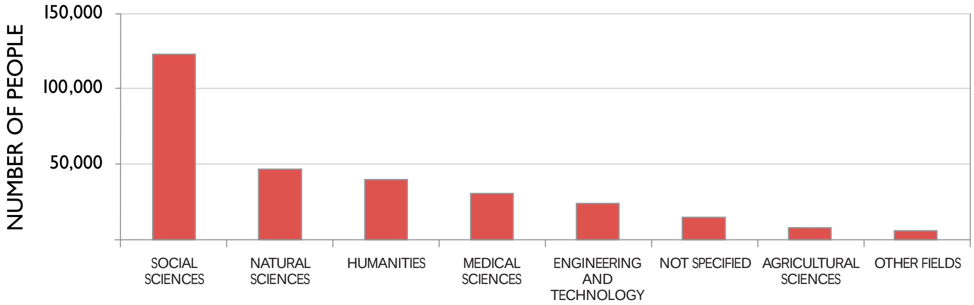
- Asian 20 percent;
- European 11 percent;
- Māori four percent; and
- Pacific Peoples three percent.

In 2001, **social sciences** is by far the most significant field of study for HRSTQ – approximately 123,000 people had university qualifications in this field of study (see Chart 8.8 below). The next most prevalent fields of study were **natural sciences** (47,000), **humanities** (40,000), **medical sciences** (30,000) and **engineering and technology** (24,000).[6]

When compared with 1996, it is apparent that the most rapidly growing fields of study were **medical sciences** (60 percent growth rate), **humanities** (50 percent growth rate), **natural sciences** (40 percent growth rate) and **social sciences** (35 percent growth rate).[7]

[6] Statistics New Zealand has advised that there are some quality issues with the field of study data due to under-reporting. See *Human Capital Statistics, 2003*, Statistics New Zealand.

CHART 8.8 FIELD OF STUDY DISTRIBUTION FOR UNIVERSITY-LEVEL HRSTQ, 2001



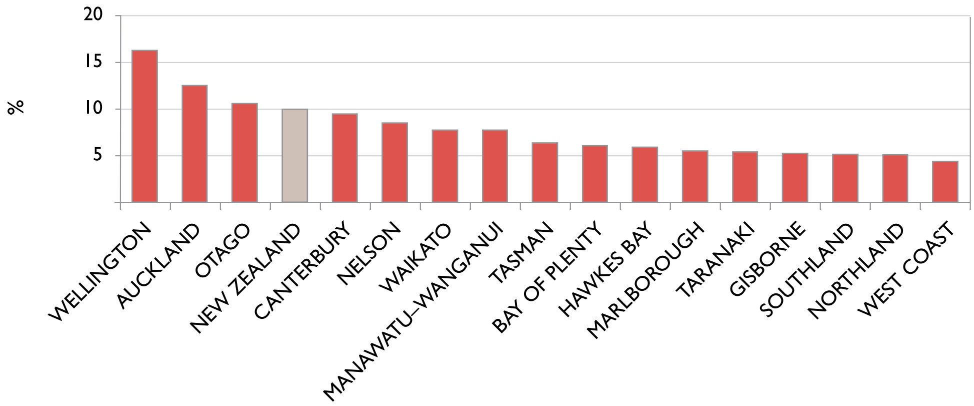
REGIONAL DISTRIBUTION OF UNIVERSITY-LEVEL HRSTQ

Chart 8.9 shows the percentage of people in each of the regions of New Zealand who are qualified as HRSTQ in 2001. It shows that the Wellington, Auckland and Otago regions had a greater-than-average share of university-qualified people. In Wellington there were 54,000 HRSTQ people, representing 16 percent of the adult population in that region. In Auckland there were 112,000 HRSTQ people, representing 13 percent of the adult population in that region, and in Otago there were 16,000 HRSTQ people, representing 11 percent of the adult population in that region.

All of the other regions had lower shares than the New Zealand average of 10 percent.

[7] Statistics New Zealand has advised that there is a degree of uncertainty associated with comparing 1996 and 2001 fields of study due to classification and questionnaire changes. In 1996, the field of study refers to the first post-school qualification; in 2001 it refers to the highest post-school qualification. The field of study classification changed from 1996 to 2001 and, although data here was output to the same categories, there are imperfect matches in some areas.

CHART 8.9 SHARE OF PEOPLE WITH UNIVERSITY-LEVEL QUALIFICATIONS, BY REGION, 2001



HRSTQ IN THE LABOUR FORCE

It is important to consider the effect of qualifications on workforce participation. Labour force status breaks down the population into three parts:

- **employed** people;
- **unemployed** people (who are actively seeking work); and
- those **not in the labour force** (who are not available for work and/or not actively seeking work).

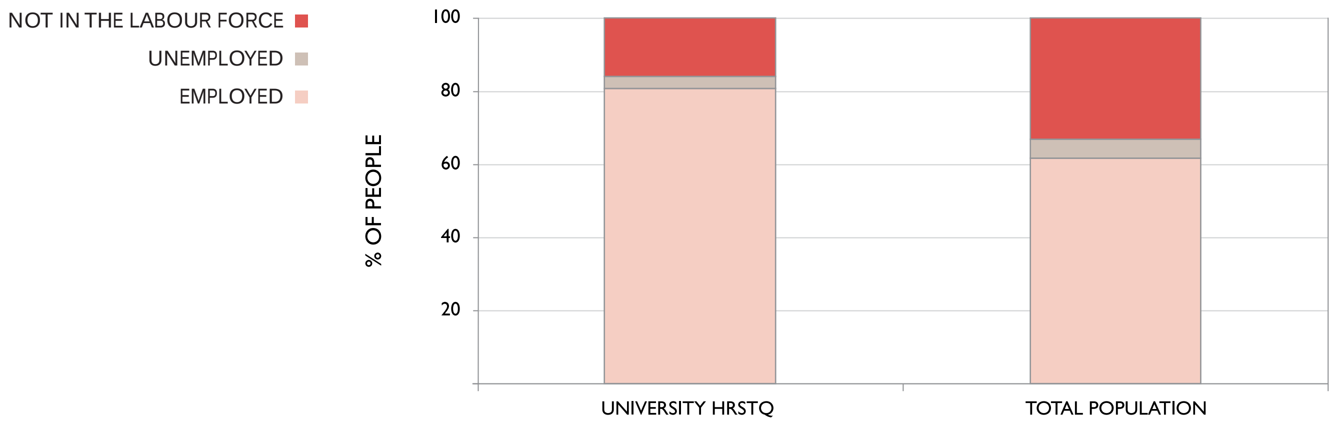
Chart 8.10 shows the labour force status for HRSTQ compared with the adult population. It shows that the share of **employed** people with university level qualifications is quite high, at 81 percent. This is much higher than for the general population – where the share of persons **employed** was 60 percent.

In 2001, unemployment in New Zealand was at a relatively low level by international standards, with an overall unemployment rate of five percent. The proportion of people **unemployed** (and actively seeking work) for HRSTQ was three percent, a little lower than the overall average. Thus there appears to be a significantly increased chance of finding a job if a person has university qualifications.

There was a much lower share of university people who were **not in the labour force** compared with the general population. For qualified people, the proportion of people **not in the labour force** was only about half that of the average for the adult population – 16 percent compared with 32 percent. The low proportion of university qualified people who are **not in the labour force** is affected by the younger age profile of this group, which has a smaller proportion of retired people.

CHART 8.10

EMPLOYMENT STATUS OF HRSTQ COMPARED WITH THE ADULT POPULATION, 2001



UNIVERSITY-LEVEL HRST OCCUPATIONAL CLASSIFICATIONS

University-level HRST occupations are classified as being **specialist managers** or **professionals (groups 1 and 2)**.

- Specialist managers include managers of production and operation, finance and administration, human resources, sales and marketing, and advertising and public relations.
- Professionals group 1 includes physicists, chemists, mathematicians, statisticians, computing professionals, architects and engineers, and health and life scientists.
- Professionals group 2 includes teaching and all other professionals.
- Non-HRST occupations include all other occupations which are not listed as specialist managers or in the professionals (groups 1 and 2).

OCCUPATIONAL DISTRIBUTION OF UNIVERSITY-LEVEL HRSTQ

Chart 8.11 shows the number of people classified into occupations that are university level HRST occupations or as non-HRST occupations for 2001.

In 2001, there were about 154,000 university-qualified people who were working in university-level occupations. Of these, 28,000 were classified as **specialist managers**, 43,000 were classified as **professionals group 1** and the rest (over half) were in the **professionals group 2** category.

A relatively small number (43,000) of university-qualified people were employed in occupations which are traditionally regarded as core science and engineering occupations.

The number of university-qualified people categorised as working in non-HRST occupations (82,000) is about half the number of those working in HRST occupations. The size of this number may be indicative of the general applicability of some university degrees to occupations across a number of fields, or the difficulty of classifying people to occupation or qualification based on a self-description of their occupation or qualification.

CHART 8.11 OCCUPATIONAL GROUPING OF UNIVERSITY QUALIFIED PEOPLE, 2001

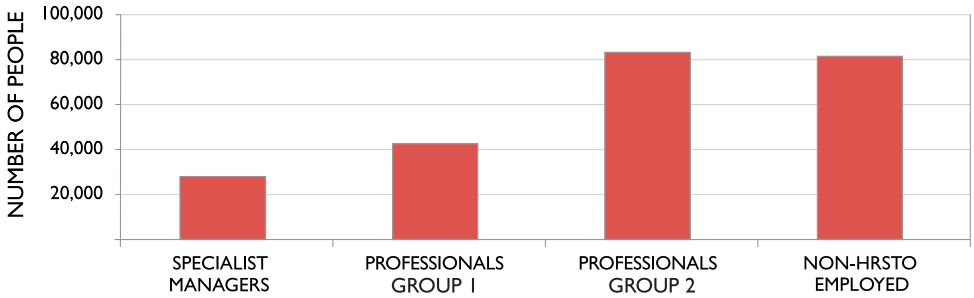
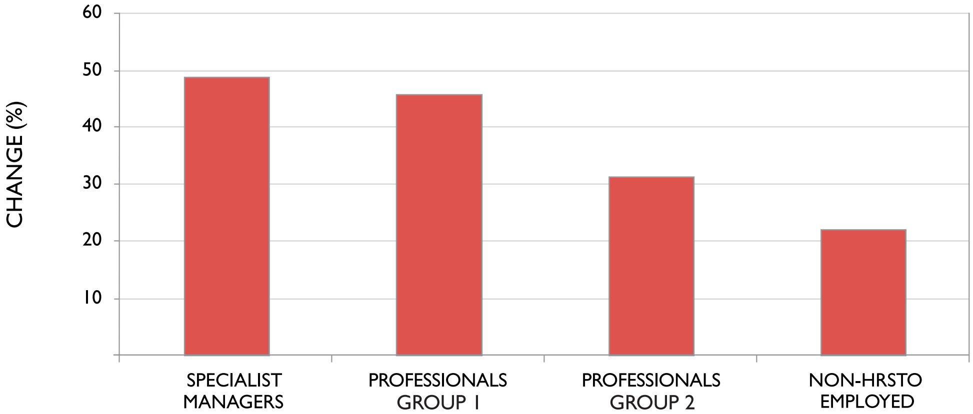


Chart 8.12 shows the increase in HRSTQ between 1996 and 2001 in the occupations discussed previously. This shows that, in this period, the number of university-qualified people working in university-level HRST occupations has grown more strongly than those in non-HRST occupations. In particular, the growth rates for **specialist managers** and **professionals group 1** (including occupations such as chemists, mathematicians, statisticians, computing professionals, architects and engineers, and health and life scientists) have both increased by between 45 and 50 percent. **Professionals group 2** (teachers, etc) has grown by 31 percent.

The growth rate for non-HRSTO occupations was just 22 percent.

CHART 8.12 PERCENTAGE CHANGE IN UNIVERSITY QUALIFIED PEOPLE BY OCCUPATION, 1996-2001



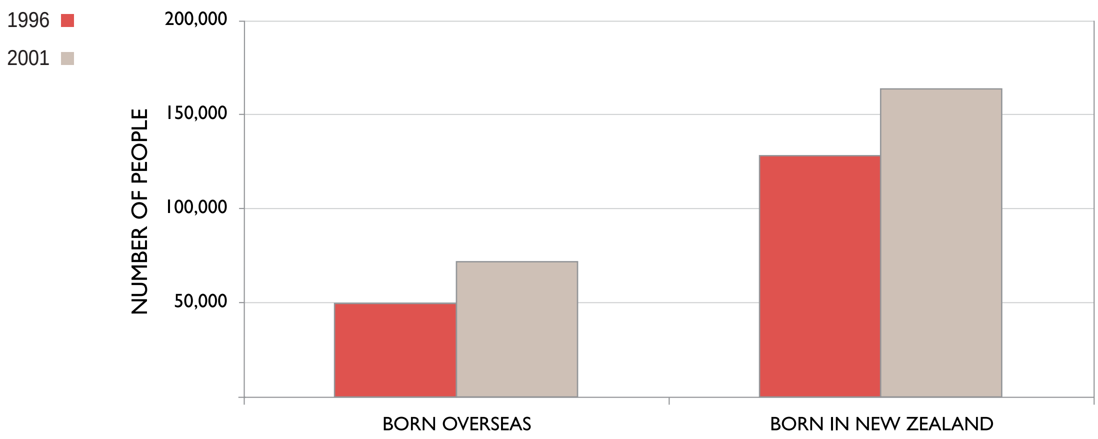
COUNTRY OF BIRTH OF UNIVERSITY-LEVEL HRSTQ

Chart 8.13 shows the number of HRSTQ in the employed population who were born overseas or in New Zealand.

In 2001, the number of university-qualified employed people who were born overseas was 72,000, compared with 163,000 born in New Zealand. Therefore, a relatively high percentage (just over 30 percent) of university-qualified employed people were born overseas.

By way of comparison, the share of the general employed population that was born overseas in 2001 was much lower, at 20 percent. The overseas-born share was similar in 1996 at 28 percent, with 49,000 born overseas and 128,000 born in New Zealand.

CHART 8.13 COUNTRY OF BIRTH OF UNIVERSITY-QUALIFIED EMPLOYED PEOPLE, 1996 AND 2001



9 MIGRATION OF SKILLED PEOPLE

MAIN FINDINGS

- Migration trends for people with university-level occupations are cyclical and broadly similar to those of the general migrating population.
- Since 2002, there have been more people with university-level occupations arriving in New Zealand than departing.
- People with university-level occupations make up a significant proportion (30 to 40 percent) of long-term migrants to and from New Zealand.
- The proportion of people with university-level occupations is greater for those arriving than departing, implying that we may be gaining skilled people through migration, not losing them.
- There has been a net loss of people of all skill levels to Australia for many years.
- This is currently balanced by a high inflow of skilled people from the United Kingdom, Asian countries and Northern America.
- More New Zealand nationals with university-level occupations are departing rather than arriving in the country, particularly in the under 30 age group.
- Skilled people of other nationalities are filling their place, resulting in a net inflow for all age groups over 30 years so that, rather than a drain of talent, we are experiencing a "brain exchange".

INTRODUCTION

Chapter 8 shows that overseas-born people make up a significant proportion of our skilled workforce – about 30 percent of university-qualified people working in New Zealand were born overseas. This implies that an important part of the supply of skilled people in New Zealand is through migration.

We present here a short summary of migration patterns relevant to human resources in science and technology (HRST). The reader is referred to a 2001 paper: *Treasury Working Paper 01/22 Brain Drain or Brain Exchange* by Hayden Glass and Wai Kin Choy (Glass and Choy, 2001) and references cited within, for a more comprehensive analysis and discussion on migration patterns and the "brain drain" hypothesis[1].

This summary uses permanent and long-term migration data from Statistics New Zealand to investigate migration flows since July 1991[2]. The data refers to people who were away or intended to stay away from their home country for 12 months or more. People are able to classify themselves by their occupation, but not by qualification. The occupational information is not very reliable (eg, Glass and Choy, 2001) for various reasons. A fair proportion of migrants do not have an occupation (children, students, retired people) or do not record an occupation because they are travelling with other family members who do have an occupation[3]. Thus a large number of people are in the **not actively engaged** or **not specified** categories. Also, there is no guarantee that a migrant will find employment in the occupational category stated on immigration forms. Nevertheless, it does provide an indicative picture of the migration of people with university level occupations.

[1] Available at www.treasury.govt.nz

[2] The start year of July 1991 was chosen because a new occupational classification was introduced in that year, which means that earlier data is not directly comparable.

[3] In the year ended June 2005, 63% of **PLT arrivals** less the **Not Applicables** and 67% of **PLT departures** less the **Not Applicables** specified an occupation that could be coded.

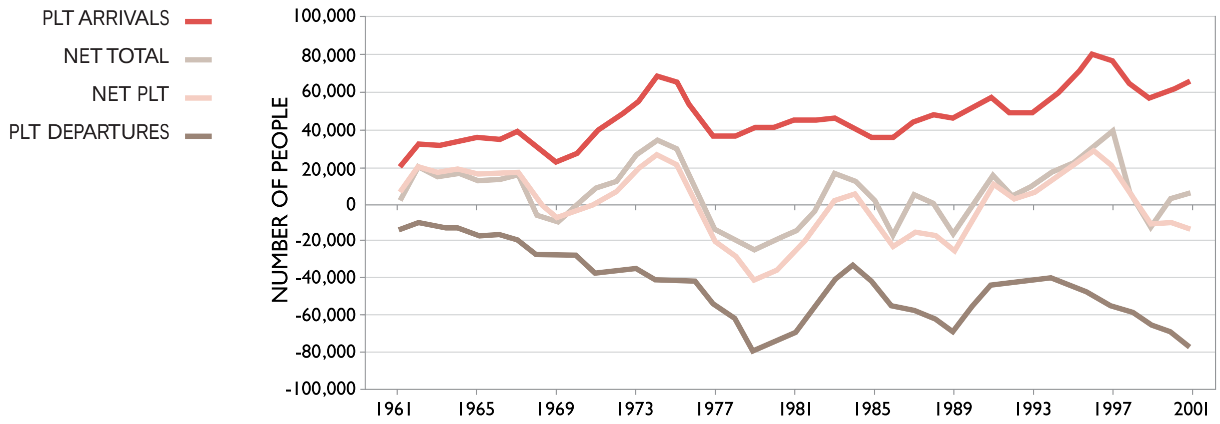
LONG-TERM TRENDS IN THE OVERALL MIGRATING POPULATION

To set the context, Chart 9.1 shows the flows to and from New Zealand for the overall migrating population. This shows the arrival, departure and net trends for permanent and long-term (PLT) arrivals and departures as well as net total migration (taking into account people whose intentions changed, so they jumped from PLT status to short-term visitor or vice versa).

CHART 9.1

PLT ARRIVALS, PLT DEPARTURES, NET PLT AND NET TOTAL MIGRATION, 1961–2001

SOURCE: Glass and Choy, 2001.



NOTE: Data refers to years ending in March.

The following points are evident:

- Arrivals and departures of the general population were cyclical over the 40-year period.
- The flows of PLT migrants have increased in size and become more volatile over the past 40 years.
- The net migration is the relatively small residual of larger flows.
- Net migration of PLT migrants is not the same as net total migration, which includes people whose intentions change. Unfortunately, occupational data is only available for PLT migrants so we must use PLT data to discuss the mobility of skilled people into and out of New Zealand.

RECENT TRENDS IN THE UNIVERSITY-LEVEL HRST MIGRANTS

Chart 9.2 updates this time series to include recent trends and also focuses on two specific groups of occupations relevant to HRST. These are:

- scientists and engineers (**professionals group 1**); and
- people with university level occupations (**specialist managers and professionals groups 1 and 2**[4])

[4] See Chapter 8 for definitions.

The trends for these two groups are shown alongside those of the total population (scaled).

As stated previously, the absolute numbers for the two occupational groups are not reliable because a large number of people do not provide useful occupational data. Thus, any inferences regarding occupation are based on a sample of people whom we hope are representative of the larger group. The chart shows the following:

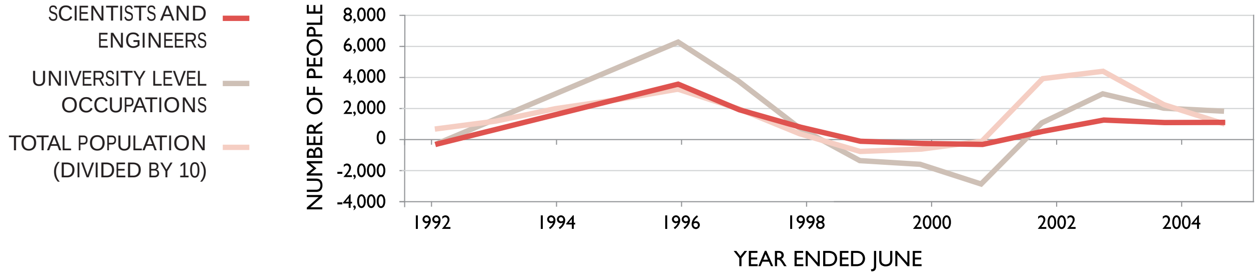
- The net migration for all three groups has been cyclical over the past decade.
- There are currently more people with university level occupations arriving in New Zealand than departing.
- The trend for scientists and engineers broadly follows that of all people with university level occupations, although the magnitude of the variations is less for this smaller group.
- The migration trends for the two skilled groups are also broadly similar to the total migrating population.

The qualitative similarity in all three trends imply that migration of people in university level occupations, including scientists and engineers, is at least partially influenced by factors which affect the entire population. Recent research[5] suggests that family reasons, lifestyle, and global security are important for attracting people to New Zealand against the counter-pulls of better career and business opportunities, remuneration packages and challenges of working overseas.

[5] From *Brain Drain to Talent Flow: Views of Kiwi Expatriates* by K. Inkson et al, Spring 2004, *University of Auckland Business Review.* www.uabr.auckland.ac.nz

CHART 9.2

NET PERMANENT AND LONG-TERM MIGRATION OF NEW ZEALAND, 1992-2005



NOTE: The numbers for the total population have been divided by 10 so that the other trends show up against the much larger numbers of the general population.

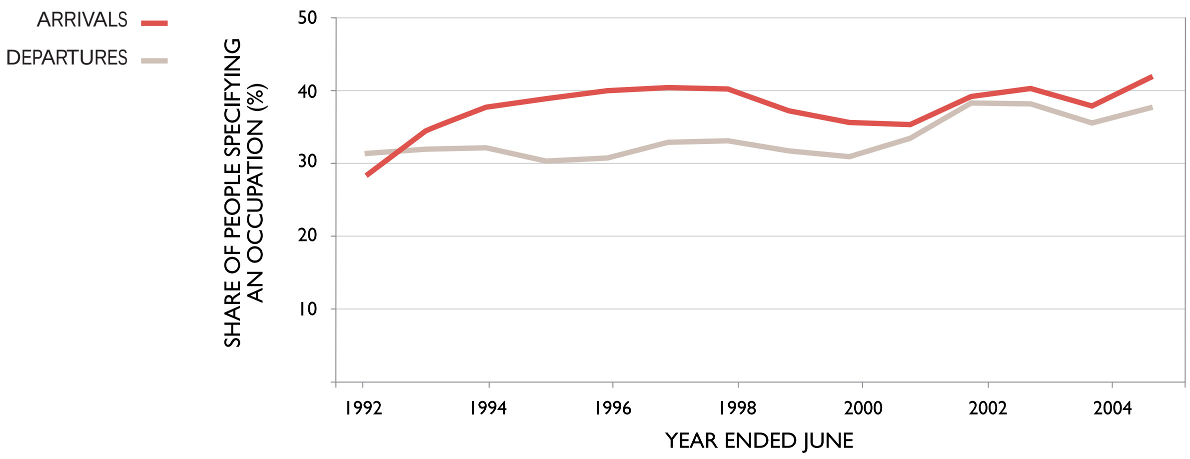
UNIVERSITY-LEVEL HRST MIGRANTS ARRIVING IN, AND DEPARTING FROM NEW ZEALAND

Chart 9.3 is based on information provided by permanent and long-term migrants to New Zealand specifying an occupation on their arrival or departure cards. The trends show that:

- people with university-level occupations make up a significant proportion (30 to 40 percent) of long-term migrants to and from New Zealand;
- this proportion changes over time and is currently higher than in the early 90s; and
- there are higher proportions of people arriving with university-level occupations than departing.

The last point implies that immigrants to New Zealand are more highly skilled than people emigrating from New Zealand. Thus, we appear to have a "brain exchange" with the rest of the world, rather than a "brain drain" (Glass and Choy, 2001). This bodes well for the supply of HRST to New Zealand, provided the migrants are able to make use of their skills.

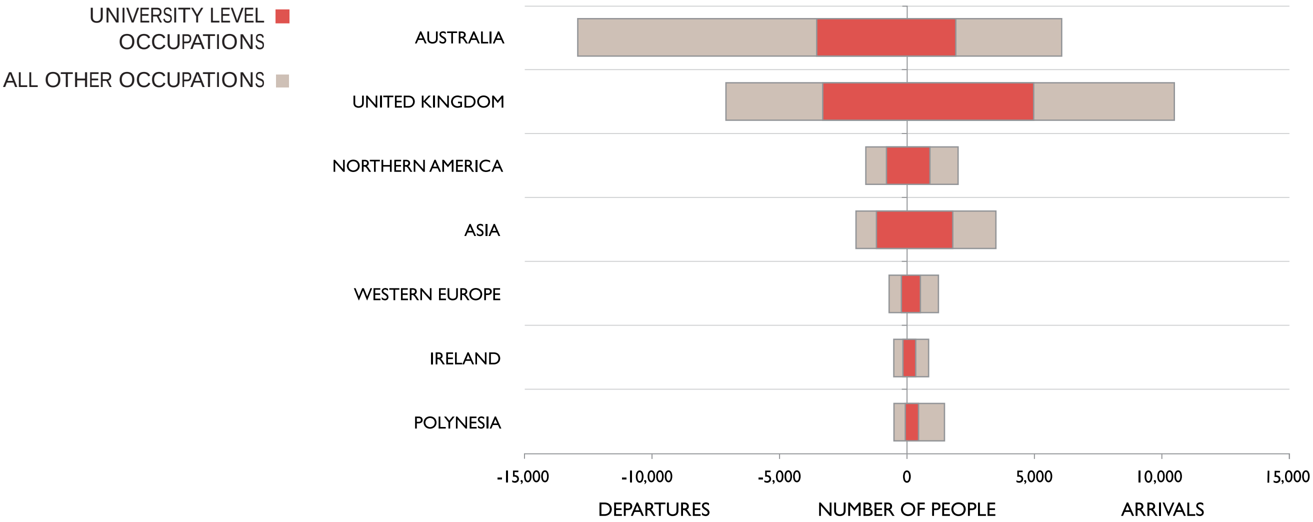
CHART 9.3 SHARE OF MIGRANTS WITH UNIVERSITY-LEVEL OCCUPATIONS, 1992–2005



WHERE DO UNIVERSITY-LEVEL HRST MIGRANTS COME FROM, AND GO TO

Chart 9.4 shows the number of permanent and long-term migrants arriving and departing New Zealand in the year ending in June 2005 by their country of last or next permanent residence. Exchanges between New Zealand and two countries – the United Kingdom and Australia – dominate migration of all people, including those with university-level occupations. The next largest flows are to and from Northern American and Asian regions. The pattern for scientist and engineers (not shown) is similar to all people with university-level occupations.

CHART 9.4 MIGRATION OF PEOPLE BY OCCUPATION LEVEL, YEAR ENDING JUNE 2005



There are large net outflows of people to Australia and large net inflows from the United Kingdom and Asian countries. Glass and Choy, 2001 show that large net outflows to Australia have occurred in almost every year since 1961 – it is not a new phenomenon. They also show that there have been net inflows from the Asian countries since 1979 and that net inflows between New Zealand and the United Kingdom are more volatile over time, sometimes positive and at other times negative.

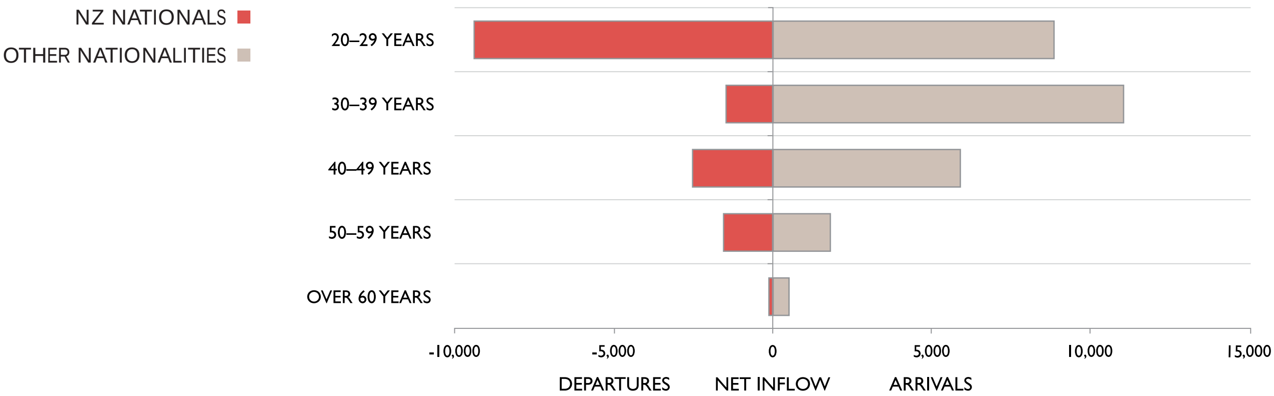
One interesting finding from the Glass and Choy study is that the migration patterns between New Zealand and Australia are different from those between New Zealand and the rest of the world. We appear to lose and gain people of all skill levels to Australia (so the university-level share for Australia in the above chart is lower than for the other dominant regions). On the other hand, we gain immigrants with higher skill levels than our general population from other countries.

INFLUENCE OF NATIONALITY AND AGE

Chart 9.5 shows net migration by nationality and age group for people with university-level occupations for the last five years.

CHART 9.5

NET INFLOW OF PEOPLE WITH UNIVERSITY-LEVEL OCCUPATIONS BY AGE BAND, 2000–2005



NOTE: Data refers to years ending in June.

The following points are evident:

- More New Zealand nationals with university level occupations are departing rather than arriving in the country.
- The "drain" of skilled New Zealanders is particularly pronounced for those below 30 years of age.
- People of other nationalities are filling their place, resulting in a net inflow for all age groups over 30 years.

The general trend of New Zealanders with university level occupations in their 20s leaving the country is not surprising. Young people have been leaving New Zealand for their "OE" for many years. In fact, this "brain drain" was a lot worse in the late 1990s. The data shows that some of these New Zealanders do return in their 30s and 40s. However, the net outflow of skilled New Zealanders is mainly balanced by an inflow of slightly older people of other nationalities. As Glass and Choy, 2001 point out, this pattern has been in place for at least 40 years and there is evidence that people migrating to New Zealand have higher skills than those departing.

BRAIN DRAIN VS BRAIN EXCHANGE

Public debate on the "brain drain" often centres on one aspect of the overall flow of skilled people to and from New Zealand – that of talented young New Zealanders leaving the country. Closer inspection of the available information shows that these young New Zealanders are currently being replaced by skilled people of other nationalities, so that, rather than a drain of talent, we are experiencing a "brain exchange" (Glass and Choy, 2001). In fact, the proportion of people with university-level occupations is higher for those arriving than those departing, implying that we may be gaining skilled people through migration, not losing them. This is good news for the supply of skilled people in New Zealand, provided migrants are able to make use of their skills.

The large departures of young, skilled New Zealanders overseas is often viewed negatively in public debate; however, there are many positive aspects to having New Zealanders become part of the globally mobile workforce. This is particularly true for the RS&T sector, where international experience and research collaborations are regarded as invaluable, if not essential for many fields. Even when New Zealanders do not return home they are able to offer valuable opportunities to other New Zealanders through research collaborations or study opportunities[6].

Most importantly, these findings emphasise the need to take a long-term view of migration patterns of skilled people and not to respond too hastily to calls to reverse the "brain drain" of young New Zealanders. The data show that net inflows of skilled people are cyclical and broadly similar to the general population. This implies they are influenced, at least partly, by factors which are unrelated to the RS&T environment within New Zealand, such as lifestyle and family reasons. This has implications for science policy makers because many influencing factors will be outside their control.

[6] From *Brain Drain to Talent Flow: Views of Kiwi Expatriates* by K. Inkson et al, Spring 2004, University of Auckland Business Review. www.uabr.auckland.ac.nz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GLOSSARY

BERD

Business enterprise expenditure on R&D. This is sum of all R&D expenditure for the private sector. This includes State owned enterprises, Research Consortia, and registered charities. Firms are classified by Statistics New Zealand to this sector. Measures of Business R&D contained in this publication generally exclude the R&D performed by small enterprises employing less than 10 persons.

BIOTECHNOLOGY

The application of science and engineering principles to living organisms as well as parts, products or models thereof, to alter living or non-living materials for the production of knowledge, goods and services. This includes the following biotechnology techniques: DNA/RNA, proteins and other molecules, cell and tissue culture and engineering, process biotechnology techniques, gene and RNA vectors, bioinformatics and nanobiotechnology.

CAPITAL EXPENDITURE

Expenditure on the acquisition of fixed tangible assets such as land, buildings, vehicles, plant, machinery and equipment. Only that part of capital expenditure attributable to R&D activity is included in this publication.

COMPARABILITY BRIDGE

An analytical adjustment to time series data affected by methodological changes in compilation methods over the period of the survey. The bridge is designed to overcome these methodological changes as effectively as possible to ensure that the most valid comparisons possible can be made over time.

CONSTANT $ EXPENDITURE

R&D expenditure estimated in terms of prices applicable in 1993-94. The base period has been chosen to coincide with the starting year of the time series presented in this publication. Presentation of statistics in constant prices enables the derivation of real growth rates over time. See Chapter 1 Methodology for more details of the methods used.

CoREs

Centres of Research Excellence were introduced during 2002/03 and are funded through Vote Education to encourage the development of world-class research in New Zealand. Each CoRE is hosted by a university and comprises a number of partner organisations, including other universities, CRIs and wananga.

CROWN ENTITY

A generic term for a diverse range of entities within one of the five categories referred to in section 7(1) of the Crown Entities Act 2004, namely: statutory entities, Crown entity companies, Crown entity subsidiaries, school boards of trustees, and tertiary education institutions. Crown entities are legally separate from the Crown and operate at arm's length from the responsible or shareholding Minister(s); they are included in the annual financial statements of the Government.

CURRENT EXPENDITURE

Expenditure on direct labour costs, materials, fuels, rent and hiring, repairs and maintenance, data processing etc. as well as general services and overheads. Only that part of current expenditure attributable to R&D activity is included in this publication. Current expenditure is classified into two components – **wages and salaries** and **other current expenditure.**

CURRENT $ EXPENDITURE

R&D expenditure estimated in terms of prices applicable at the time that the expenditure was incurred. The time series of data published in this way has not been adjusted for inflation and hence provides nominal growth rates over the period.

FRASCATI MANUAL

The *Frascati Manual* is the OECD manual outlining the standard practices for the conduct and interpretation of surveys of research and experimental development. It is used widely by Member countries of the OECD as well as many other countries throughout the world. The current edition issued in 2002 represents the 6th edition of this publication.

FTE PERSON YEARS OF EFFORT

The human resource input into R&D is measured in terms of person years. One full-time equivalent (FTE) year of effort is equal to a full-time employee whose time is wholly devoted to R&D for a whole year.

GERD

Gross Expenditure on R&D. Estimates of GERD are derived by adding up the estimates of R&D performed in the Business, Higher Education and Government sectors of the economy. Hence the estimates of GERD contained in this publication excludes certain areas, as noted under the sector definitions.

GOVERD

Government sector expenditure on R&D. This is sum of all R&D expenditure for the government sector. This includes CRI's, government departments and agencies, local government and health boards. This does not include funding of R&D by government to other sectors. In this publication we generally report only the expenditure by CRIs (the major component, which has been measured consistently).

GDP

Gross domestic product represents the country's income earned from production in New Zealand. It includes income from production carried out by New Zealanders and by foreign firms operating within New Zealand.

HERD

Higher Education Expenditure on R&D. This is the sum of all R&D expenditure for the Higher Education sector. In New Zealand, the collection of R&D statistics is currently restricted to the eight universities. While it is reconigised that other tertiary providers do undertake R&D, they have not previously been surveyed, and so are not included in this publication.

HRST

Human resources in science and technology (HRST) is defined by two parameters – qualifications (HRSTQ) and occupations (HRSTO). These represent respectively the supply of people to the science and technology system and the demand for them. Total HRST can then be seen as being the sum of these two categories, with the overlap between them being what is considered to be the 'core' of HRST, or HRSTC.

HUMAN RESOURCES DEVOTED TO R&D

The effort of researchers, technicians and other support staff directly involved with R&D activity. Overhead staff (eg, central finance or cleaning services) whose work indirectly supports R&D are excluded.

OTHER CURRENT EXPENDITURE

Includes expenditure on consumables, overheads (including rent and travel), wages and salaries for staff indirectly supporting R&D (eg, central finance or cleaning services), on-site consultants or contract staff and operating leases. Depreciation is not included.

OTHER SUPPORT STAFF

Administrative and managerial staff working on, or directly associated with, R&D activity. Excludes staff providing indirect support to R&D activity (eg, central finance or cleaning services).

PBRF

Performance-based Research Fund. Funding for research at tertiary education institutes, sourced from Vote Education and administered by the Tertiary Education Commission.

R&D

R&D is defined by the OECD *Frascati Manual* as creative work undertaken on a systematic basis to increase the stock of knowledge available to society and the use of this knowledge to devise new applications. The basic criterion for distinguishing R&D is that it must contain an appreciable element of novelty and the resolution of scientific and/or technological uncertainty. Most of the statistics contained in this publication relate to inputs into the performance of R&D in terms of expenditures and human resource inputs. This publication also includes statistics about the funding of the R&D performed in New Zealand.

RESEARCHERS

Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned.

RME

The number of employees is defined by an enterprise's Rolling Mean Employment count. RME is a twelve-month moving average of the monthly Employment Count (EC) figure. The EC is obtained from taxation data.

SOCIO-ECONOMIC OBJECTIVE (SEO)

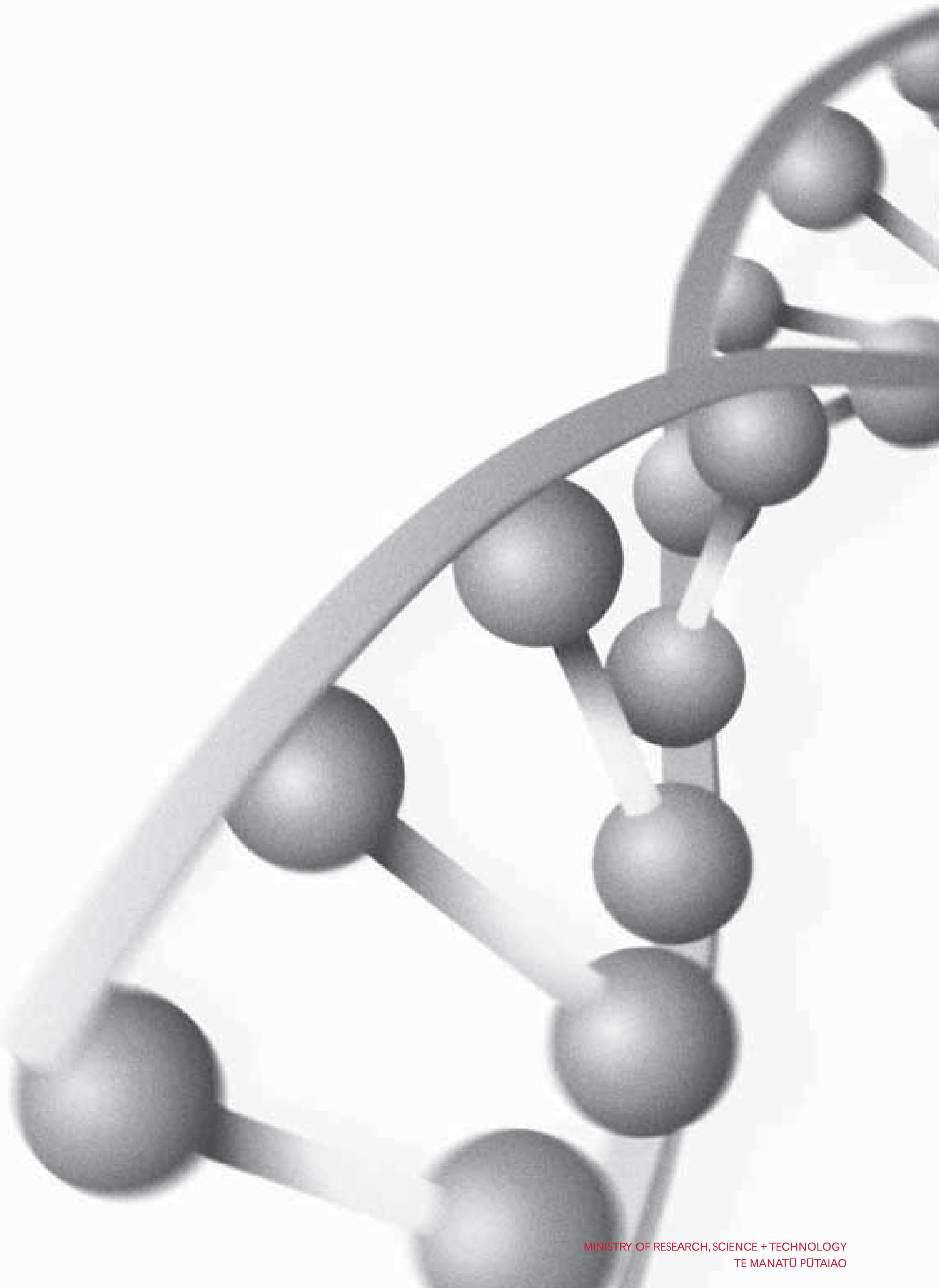
The broad socio-economic areas of expected benefit rather than the immediate objectives of the researcher. The SEO classification defines the main areas of New Zealand's economic and social activity to which the results of research programs are applied. In short, it describes the purpose of the research.

TECHNICIANS

Those performing technical tasks in support of R&D activity, normally under the direction and supervision of a researcher. These tasks include preparation of experiments, taking records, preparation of charts and graphs, etc.

WAGES AND SALARIES

Expenditure on wages and salaries for personnel performing R&D (including staff directly supporting R&D). This includes overtime, ACC, fringe benefits, redundancy, severance payments and other related costs.



APPENDIX

This appendix summarises the methodological basis for the series analysed in this report. Readers interested in more complete detail are invited to inspect a more detailed document at www.morst.govt.nz.

BACKGROUND

MoRST and Statistics New Zealand have been conducting regular surveys of R&D in all sectors of the New Zealand economy since 1990. The outputs from these have been published in regular reports. Each of the surveys conducted to date has essentially been undertaken as a snapshot of the R&D performed in New Zealand in that time period. As such, the surveys have been subject to the financial, provider load, timing and other constraints operating at the time the survey was run.

For the purposes of undertaking a more detailed analysis over time of New Zealand R&D performance, it is necessary to have a time series of data that consistently measures trends in R&D over time. For this reason it has been necessary to make some modifications to the series already published by MoRST and Statistics New Zealand, to overcome breaks in the series created by changes in the statistical methodologies adopted from time to time. The revisions relate to the surveys in each of the institutional sectors identified in the R&D survey programme – Business, Government (including CRIs) and Higher Education – and are discussed separately below.

THE STARTING POINT FOR THE SERIES

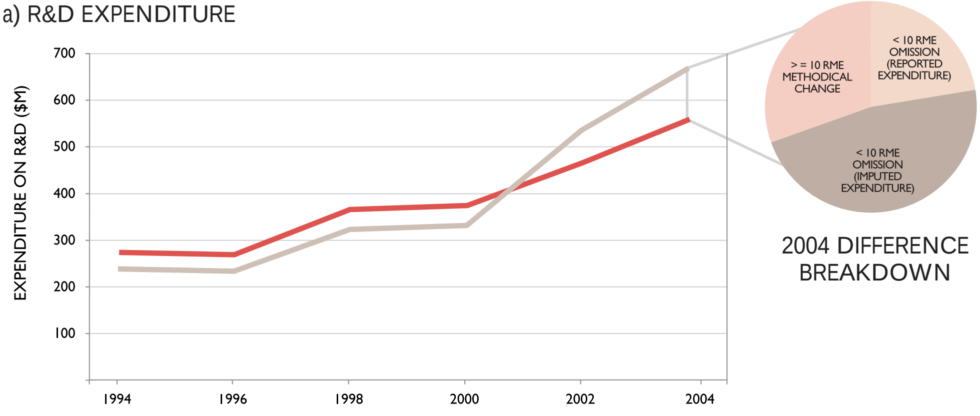
Although surveys have been conducted in New Zealand since around 1990, data for the earlier years is not sufficiently detailed to be included into a consistent time series with more recent data. Hence, for the purposes of this analysis, data has been compiled from 1993/94 to 2003/04 for the Business and Government sectors, and from 1994 to 2004 for the Higher Education sector.

THE BUSINESS SECTOR

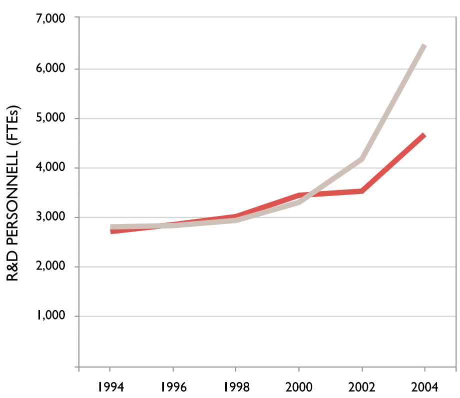
There have been a number of changes to the methodology adopted for surveys of this sector over the decade being reviewed. The adjustments noted below have been made to the series to try and overcome these discontinuities. The overall impact of these changes is shown in the charts below, where original reported values for number of firms performing R&D, total business R&D expenditure and total R&D personnel are plotted alongside the series used in this report. For number of firms, the number actually reporting R&D in the survey is also included.

COMPARABLE SERIES
ORIGINAL SERIES
RESPONDENTS REPORTING R&D

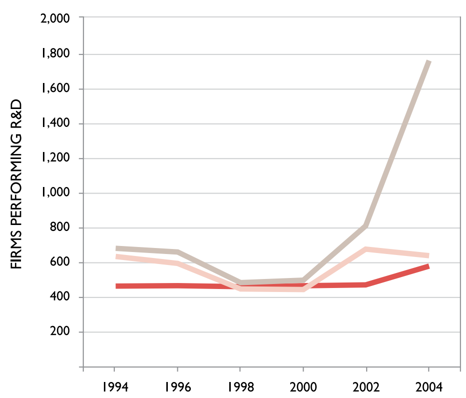
a) R&D EXPENDITURE



b) R&D PERSONNEL



c) NUMBER OF FIRMS



OMISSION OF R&D PERFORMED BY SMALL ENTERPRISE

When analysing the series for businesses with fewer than 10 employees, it became apparent that there was considerable volatility in the estimates of the amount of R&D reported by these small enterprises. This volatility relates to both sampling and non-sampling errors, in particular those non-sampling errors associated with the identification of *Frascati Manual*1 R&D. For these reasons firms with fewer than 10 employees have been excluded from the comparative time series. The exception to this has been in respect of the scientific research industry (ANZSIC2 code L781), for which both sampling and non-sampling errors were sufficiently small.

The overall impact of this change has been to reduce the value of R&D recorded in each of the years by amounts ranging from about seven percent to 14 percent.

It is important to point out that the exclusion of these small businesses from the scope of the statistics included in this report should not be interpreted as an indication that businesses of this size cannot and do not perform R&D. The reason for their omission is based on concerns that we do not have a reliable measure of R&D activity from these firms over time. Difficulty in surveying small firms is not unique to New Zealand – many other countries exclude firms with fewer than 10 employees in their standard survey methodology due to their relatively small contribution to total R&D.

[1] OECD, 2002. *Frascati Manual: Proposed standard practice for surveys on research and experimental development.* This manual provides standard definitions relating to collection of R&D data through surveys, and is used throughout OECD member countries.

[2] Australia – New Zealand Standard Industry Classification.

SAMPLING APPROACH ADOPTED FOR THE 2004 SURVEY

For all surveys conducted prior to the 2004 survey, a list-based approach was adopted. This followed common international practice for such surveys. For the 2004 survey, MoRST and Statistics New Zealand implemented a strategy in which the Statistics New Zealand Business Register provided a framework from which a sample was selected for the survey. The end result of this strategy was a marked increase in the estimated value of R&D occurring in New Zealand. To overcome this methodological change, a comparability bridge was developed as a linking mechanism.

For a number of reasons, including the fact that estimates for all previous years were on the basis of a list-based survey, the mechanism in this comparability bridge was aimed at bringing the 2004 estimates onto the same basis as the 2002 survey. This has necessitated making some assumptions about the sampling and related impacts of the 2004 survey results. The overall effect of changes to R&D expenditure reported by the Business sector has been to reduce the value of estimated R&D in 2004 by an amount of about six percent of the total estimated by this survey.

CHANGE IN SCOPE OF THE LIST ADOPTED FOR THE 2002 SURVEY

When conducting the 2002 survey, the number of potential R&D performers surveyed increased quite dramatically. This introduced a break in the series at that time. However, the methodology allowed the new units included in the survey to be identified and enabled a reliable estimate of the extent of this break on the 2002 survey results. This provided a mechanism for adjusting 2000 and earlier year surveys to this new basis. The mechanism adopted was to develop adjustment factors for industry and size groups for each of the key data items in the survey, and to apply these factors retrospectively to the published data for earlier years.

The overall impact of this adjustment on years previous to 2002 was to increase the value of R&D recorded by amounts ranging from nine percent to 19 percent.

CHANGE IN SCOPE OF THE LIST ADOPTED FOR THE 1998 AND 2000 SURVEYS

When conducting the 1998 and 2000 surveys, the number of potential R&D performers surveyed was decreased compared with previous years, mainly to reduce the cost of conducting the survey. Unfortunately, there was no mechanism developed at the time to enable the measurement of this methodological change for those surveys. It has therefore been necessary to estimate this impact based on the number of reporting, low-spending R&D firms in particular size ranges between 1996 and 1998. This adjustment was applied to all key data items of firms in these strata in the 1994 and 1996 surveys to bring them in line with the 1998 and 2000 survey results.

The overall impact of this adjustment was very small in terms of expenditure and human resource input, but did affect the estimated number of R&D-performing businesses.

ALLOCATION OF R&D TO INDUSTRY

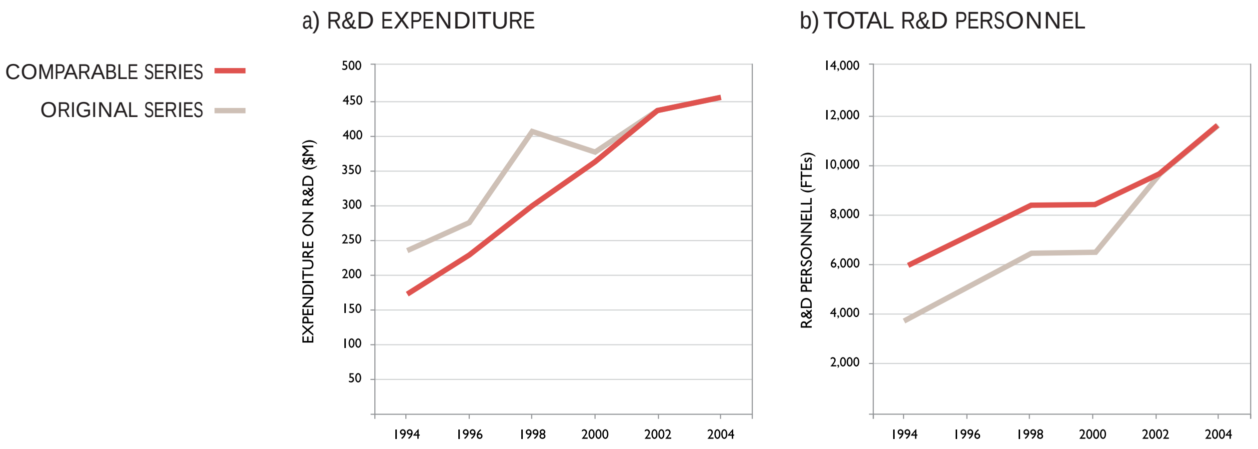
In the published R&D survey results for more recent surveys, MoRST and Statistics New Zealand have adopted the procedure of changing the industry code of some of the very largest R&D performers so that the code reflects more closely the type of R&D being performed by those enterprises. This is a procedure that has been adopted by a number of other OECD member countries, primarily where socio-economic objective is not also collected. This recoding procedure has not been adopted in this report. Instead, the published statistics reflect the actual industry code of the businesses performing R&D. In general, the overall impact of this change is zero at the total level, but does impact the industry distribution considerably.

THE HIGHER EDUCATION (UNIVERSITY) SECTOR

The University sector R&D collection is largely based on the collection of some fairly broad level staffing, income and funding items and the application of an estimation methodology developed jointly by MoRST, Statistics New Zealand and the New Zealand Vice-Chancellors' Committee (NZVCC). The estimation methodology reflects an overall agreed view of the share of university staff time and expenses that should be allocated to R&D and the amount that should be allowed for the overhead costs of that R&D. The methodology also includes the use of standard fractions for the allocation of time and expenditure amongst various classifications.

The current methodology has been in place since 2002. Prior to that survey, the University sector survey results were still largely based on an estimation methodology but one that was a little different from that used currently.

For this report, data for the years 1994 to 2000 has been re-estimated using the methodology currently in place. The overall impact of this adjustment on expenditure in years previous to 2002 was to reduce the value of R&D recorded by between three percent and 26 percent. Human resource effort on R&D was also recalculated for both staff and post-graduate students using the current methodology. The overall result for post-graduate student effort was an increase to the reported levels prior to 2002. The charts below illustrate the revisions we have made by comparing the original reported University sector R&D expenditure and number of personnel, with the series used in this report.



THE GOVERNMENT SECTOR

In this report, only CRI R&D is reported for the Government sector. This differs from the published reports which also include R&D reported by government departments and agencies and local government.

This change in scope has been made for three main reasons. Firstly, an analysis of the non-CRI units included in the results for previous years indicates that the list of units reporting R&D has not been consistent and could not be reconciled. Secondly, the data reported by some of the organisations that have reported R&D appears to contain expenditure on projects that do not meet the strict definitions of the *Frascati Manual* R&D. Thirdly, it appears that some government department financing of R&D has previously been reported as expenditure, and therefore double counted. For these reasons, R&D performed by non-CRI government organisations has been excluded from this report.

It is important to point out that the exclusion of these organisations from the scope of the statistics included in this report should not be interpreted as an indication that they cannot and do not perform R&D. The reason for their omission is based on a belief that we do not have reliable measures of such R&D activity over time. These units are much more important as funders of R&D rather than performers, and so excluding them from the survey has made only a small reduction to gross estimates of R&D performed in New Zealand.

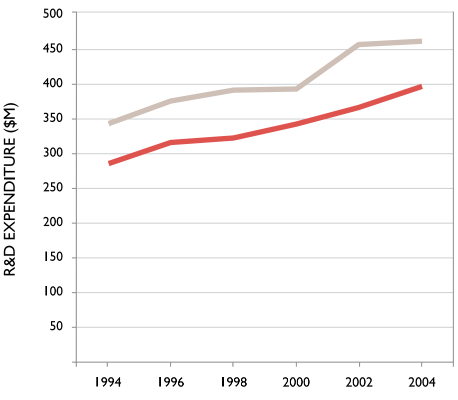
The data for the CRI sector included in the published reports made by MoRST and Statistics New Zealand appears to be largely consistent over time. The one exception to this is in respect of a large research programme performed within the CRI sector which, in the 2004 collection, it was decided fell outside the definition of Frascati R&D. To ensure that the time series in this report is as consistent as possible over time, adjustments to the data previously reported by the CRI concerned have been made using a methodology developed by Statistics New Zealand.

The charts below illustrate the differences between the CRI series reported here and the original published GOVERD series.

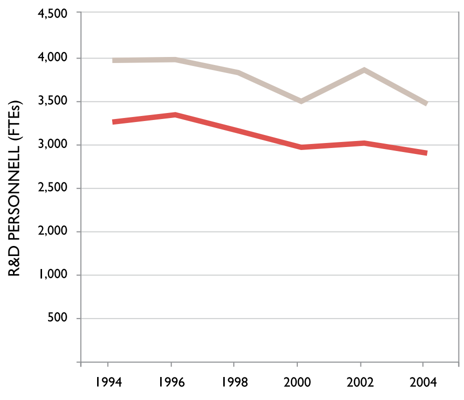
COMPARABLE SERIES

ORIGINAL SERIES

a) R&D EXPENDITURE



b) R&D PERSONNEL



Chapter 6 of this report details government financing of R&D activities for the 2005/06 financial year.

PRICE DEFLATION

Constant price series were calculated using price deflators supplied by Statistics New Zealand. Where possible, we have used a price deflator that is designed to measure the change in input costs of the industry/sub-industry for which expenditure data on various inputs are measured. The purpose of doing this is to ensure that the effect of changes in the costs of these inputs are removed from the series, so that we have a measure of the real level of inputs or purchases for a given firm/ industry.

Price indexes are selected based upon their relevance to the value series that is to be deflated. Labour Cost Indexes (industry-based) were used to deflate expenditure on wages and redundancy payments. Producer Input Price Indexes (again, industry-based) were used to deflate other current expenditure – that is, expenditure on goods and services – and Capital Goods Price Indexes (asset-based) were used to deflate expenditure on land, buildings and other capital asset purchases.

From a technical perspective, the actual calculations taking place were reasonably straight-forward. Once the appropriate price index had been selected, its quarterly index values were converted into a simple yearly average. The values for the industry series were then deflated by multiplying their value for the year by the ratio of Base Price Index over Current Price Index. The process of doing this leads to a "Constant Price Series" where the value of expenditure by an industry for a particular year is measured using fixed prices, so that only the real change in volumes is shown.

The base period selected was the year 1994, as this was the first year for which values to deflate were available.