ECONOMIC IMPACT OF PUBLIC R&D ACTIVITY IN AUSTRALIA

This report was prepared for the
Department of Education, Science and Training
by Econtech Pty Ltd.

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Executive Summary

Introduction

The Productivity Commission is undertaking a research study into the returns of public support for science and innovation in Australia. This public support has been notably augmented in recent years. *Backing Australia's Ability – Building our Future through Science and Innovation,* is a package announced by the Prime Minister on 6 May 2004 totalling $5.3 billion over seven years from 2004/05 and builds on the initial 2001 *Backing Australia's Ability* (BAA) funding of $3 billion over five years to 2005/06. Together, these two packages constitute a $8.3 billion integrated 10-year commitment to science and innovation.

The Department of Education, Science and Training (DEST) is preparing a submission for the Productivity Commission inquiry and commissioned Econtech to model the economic benefits of public funding of research and development (R&D), using the BAA as an illustration. In the absence of detailed information about the BAA program, Econtech assessed the economic benefits of the BAA program using national and international literature on the returns to publicly funded R&D.

Background

Australia's R&D expenditure is not very high compared with international standards. In 2002, Australia spent around 1.69 per cent of gross domestic product (GDP) on R&D[1], below the averages of 2.25 per cent for the OECD as a whole and 1.95 per cent for the European Union (EU)[2]. Nonetheless, this research and development support has been notably augmented over the years. Indeed, Australia's gross domestic expenditure on R&D (GERD) as a percentage of GDP has generally been growing since the 1970's. Furthermore, over the period 1992-2002, Australia increased its GERD measured as a share of GDP by 0.17 percentage points, compared to 0.08 percentage points for the OECD as a whole and the EU[3].

In 2001, recognizing the need to further invest in systems that support the creation and development of new ideas in order to generate sustainable economic growth, the Commonwealth government introduced an innovative program, *Backing Australia's Ability* (BAA).

Backing Australia's Ability is a $3 billion package announced in 2001 to encourage and support science and innovation to enhance Australia's economic prosperity, international competitiveness and social well-being. On May 2004, the Prime Minister announced a new package that builds on the 2001 funding. *Backing Australia's Ability – Building Our Future through Science and Innovation* is a package totalling $5.3 billion over seven years from 2004-05. Together, these packages constitute a ten year, $8.3 billion commitment to science and innovation stretching from 2001-02 to 2010-11.

The BAA pursues excellence in research, science and technology, through three key areas:

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[1] This figure includes public and private expenditure on R&D.
[2] Department of Education, Science and Training, "Australian Science and Technology at a glance 2005"
[3] Ibid.

- research and development;
- commercialization; and
- skills development.

Literature Survey

The relationship between publicly funded research and economic performance is an increasingly significant topic in the academic literature. There have been various attempts to estimate the impact of R&D on productivity. The majority of studies find a positive rate of return, and in most cases the figure is quite high.

In general, the studies reviewed for this report use four different approaches to estimate the economic benefits of publicly funded R&D:

- The economic surplus approach. This approach evaluates productivity changes that can be attributed to research. Productivity changes are interpreted as shifts in the supply function.

- The production function approach. This approach relies on the estimation of production functions that contain R&D expenditures as an explanatory variable.

- The total factor productivity approach. This approach is a variant of the production function approach where instead of relating R&D to output, R&D is related to the growth in total factor productivity (TFP).

- The return of investment approach. This approach estimates the rate of return that makes the discounted flow of costs and social benefits of R&D add up to zero.

As mentioned before, much of the econometric literature shows consistent findings of a significant and positive rate of return to publicly funded R&D investments. Furthermore, the literature survey in this report shows that there is great variation in the estimated rates of return by sector and by study. In spite of this variation, many studies place the economy-wide social rate of return on overall publicly funded research in the order of 25 to 40 per cent a year.

In the Australian context, a study was recently conducted to measure the delivered benefits of a major Government R&D funding program in Australia. The Allen Consulting Group's study (2005) makes an assessment of the economic impacts of the Cooperative Research Centres (CRC) Program. The key finding of this study is that over the period 1992-2010, the Australian economy's overall performance has been considerably enhanced when compared to the performance that would have occurred in the absence of the investment on the CRC Program. Over the 1992 to 2010 period, results from the economic impact assessment indicate that gross domestic product, real consumption, real investment and taxation revenues are higher that would have occurred had the money spent on the CRC Program instead gone to general government expenditure. Specifically, GDP is cumulatively (in 2005 dollars) $1,142 million higher, real consumption is cumulatively $763 million higher, real investment is cumulatively $417 million higher, and Commonwealth taxation revenue is cumulatively $66 million higher.

The Allen Consulting Group's study represents the first attempt to measure the benefits of a major government R&D funding program in Australia. This study is useful in that it provides information about the gross benefits derived from the CRC program.

In comparison, this Econtech study effectively extends the Allen Consulting Group's results by estimating the actual and future net benefits of the BAA program (including the CRC). There are two important differences between these studies.

- Firstly, this Econtech study includes estimates of the current and future benefits of the BAA (including the CRC). In comparison, in the Allen Consulting Group study, the criteria used to measure the benefits of the CRC program only included the already delivered or apparent benefits (not the forthcoming benefits from past investments in research). That is, benefits in the "pipeline" were excluded from the economic impact assessment. The consequence of this, as recognized by the Allen Consulting Group, is that the study presents only a partial calculation of the benefits delivered by the CRC program.
- Secondly, this Econtech study estimates the net benefit of the BAA (including CRC). The net benefit is defined as the gross benefit less the costs of the program. In comparison, the Allen Consulting Group's excluded the cost of the CRC program. That is, the authors unconventionally assumed that if the Commonwealth had not funded the CRC program, the money would have been allocated across other government expenditure.

Modelling Approach

The impact of public R&D activity on the Australian economy is estimated using the MM600+ model. MM600+ is a long-term computable general equilibrium (CGE) model of the Australian economy that models a long-run equilibrium (approximately 5 to 10 years). It distinguishes 108 industries that produce 672 products, making it six times more detailed than any comparable model.

MM600+ has the following important features that make it well suited for the analysis in this report.

- It estimates the effects of policy changes on key macroeconomic aggregates such as GDP, exports, imports, consumption and investment.
- It breaks down the effects of policy changes into 108 industries and 672 products. This means that the model is able to estimate the impacts of public R&D activity across industries and products.
- For each industry and product, it produces comprehensive results including for production, employment, consumption, trade flows and prices.
- It provides valid measures of changes in consumer welfare or living standards based on compensating and equivalent variations so that policy changes can be correctly evaluated in terms of the public interest.

There are two sets of shocks that Econtech applied to the MM600+ model in each simulation. One set of shocks is related to the benefits of the R&D activity, and the other to its costs.

The benefits of the BAA program and of the public R&D activity as a whole are estimated using information about the allocation of funds to the BAA program and to the public R&D activity, and the rates of return on public R&D investments obtained from the national and international literature. The range of internal rates of return used to calculate the benefits range from 10 to 30 per cent per annum depending on the sector and type of R&D. Based on this information, Econtech estimated the productivity gains in each industry that are introduced into the MM600+. Importantly, the BAA program provides funding for ten years from 2001-02 to 2010-11. Econtech only used the public R&D data for this period to calculate the perpetual benefits of the BAA program. Also, to be consistent with the BAA Scenario, the Public R&D Scenario only models the effects of ten years of public R&D funding, from 2001-02 to 2010-11.

As all the modelling in this study is in perpetual terms, the costs of the BAA program and of the public R&D activity as a whole were calculated as a perpetuity using a 5 per cent discount rate. This discount rate reflects the cost of funding for the government, which is the real interest rate of government bonds.

Results

The estimation of the economic contribution of the BAA program and the public R&D activity as a whole involves four alternative scenarios, the BAA Baseline Scenario, the BAA Scenario, the Public R&D Baseline Scenario and the Public R&D Scenario. The difference in economic outcomes between the BAA Scenario and the BAA Baseline Scenario, determines the economic benefits of the BAA program. Similarly, the difference in economic outcomes between the Public R&D Scenario and the Public R&D Baseline Scenario, determines the economic benefits of the public R&D activity as a whole.

Chart A shows the net national macroeconomic benefits of the BAA program and public R&D activity as a whole. These net benefits include the increase in labour productivity *and* the cost of the BAA program or the public R&D activity (i.e. the increase in government spending).

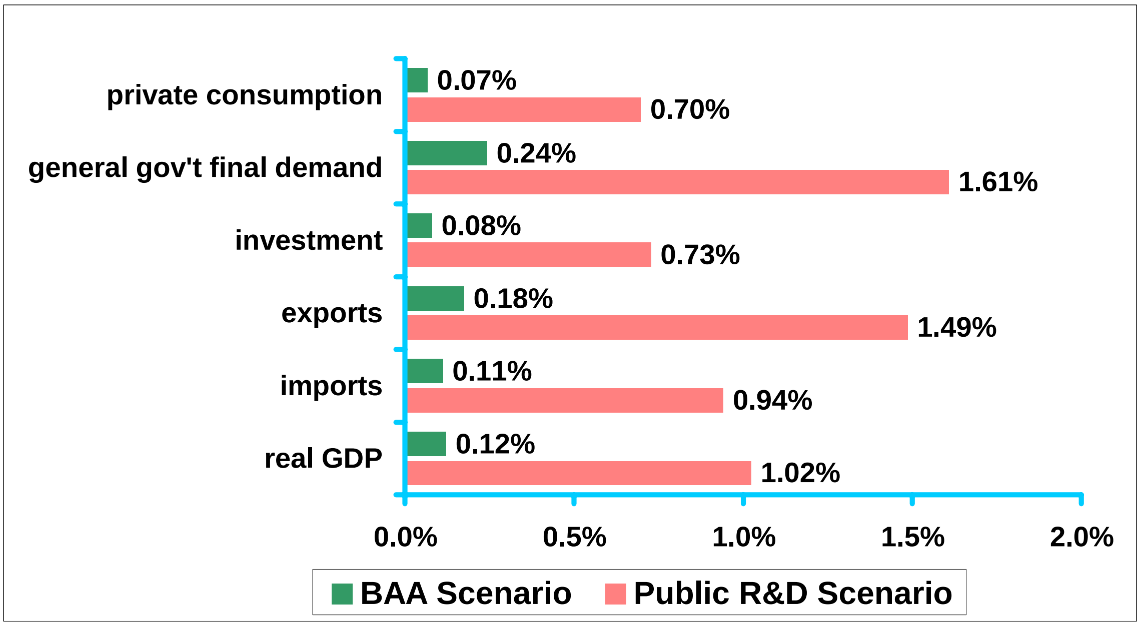
The net effect of public R&D activity on private consumption includes two impacts. The first impact comes from the cost of the R&D activity. Both the BAA program and the public R&D activity as a whole, represent an increase in government spending. In this study, it is assumed that this increase in government spending is funded by income tax being higher than otherwise. With income tax higher than otherwise, consumer spending is lower because private consumption is diverted to government consumption to pay for R&D activities. The second impact on private consumption comes from the benefits of the R&D activity. In the long run, the effect of higher productivity in industries is passed on to consumers in the form of lower prices for consumer goods and services. Lower consumer prices arising from the productivity growth translate into higher real private consumption. Since the benefits of the R&D activity are higher than the costs, Chart A shows a net improvement in private consumption under the BAA Scenario of 0.07 per cent per annum when compared to the BAA Baseline Scenario, and a net improvement under the Public R&D Scenario of 0.70 per cent per annum when compared to the Public R&D Baseline Scenario.

Further, Chart A shows the impact of the BAA program and public R&D activity on government consumption, investment, exports, imports and real GDP. This chart shows that with the BAA program, the real GDP is 0.12 per cent higher than under the BAA Baseline

Scenario. That is, the productivity gains achieved through the BAA program lead to a long-term increase in real GDP of 0.12 per cent per annum, when compared to the BAA Baseline Scenario. This is equivalent to about $1,072 million of real GDP in 2004/05 (2005 prices)[4].

The chart also shows that the effect of having public R&D activity versus not having public R&D activity is an increase in real GDP of 1.02 per cent per annum. This is equivalent to about $9,116 million of real GDP in 2004/05 (2005 prices)[5]. In comparison with the macroeconomic effects of the BAA program, the economy-wide effects of public R&D activity are much bigger. This is a logic result since the BAA program is just a small part of the budget assigned to R&D activity in Australia.

Chart A
Net National Macro-economic Effects
(% deviation from baseline)



Source: Econtech MM600+

The productivity gains stemming from the R&D activity lead to an expansion of the Australian economy as a whole, including the level of exports, imports and investment (*all other things being equal*). To accept these additional exports, the world market would ask for a lower price. Therefore, to maintain the external balance, export volumes need to rise more than import volumes. Chart A shows these impacts under each scenario. In both the BAA Scenario and the Public R&D Scenario, exports increase more than imports when compared to their corresponding Baseline Scenario. In the BAA Scenario, exports are higher by 0.18 per cent per annum (equivalent to about $296 million of exports in 2004/05, 2005 prices)[6] while imports increase by only 0.11 per cent per annum (equivalent to about $208 million of imports in 2004/05, 2005 prices)[7]. Under the Public R&D Scenario this effect is similar, exports show an increase of around 1.5 per cent per annum (equivalent to about $2,449

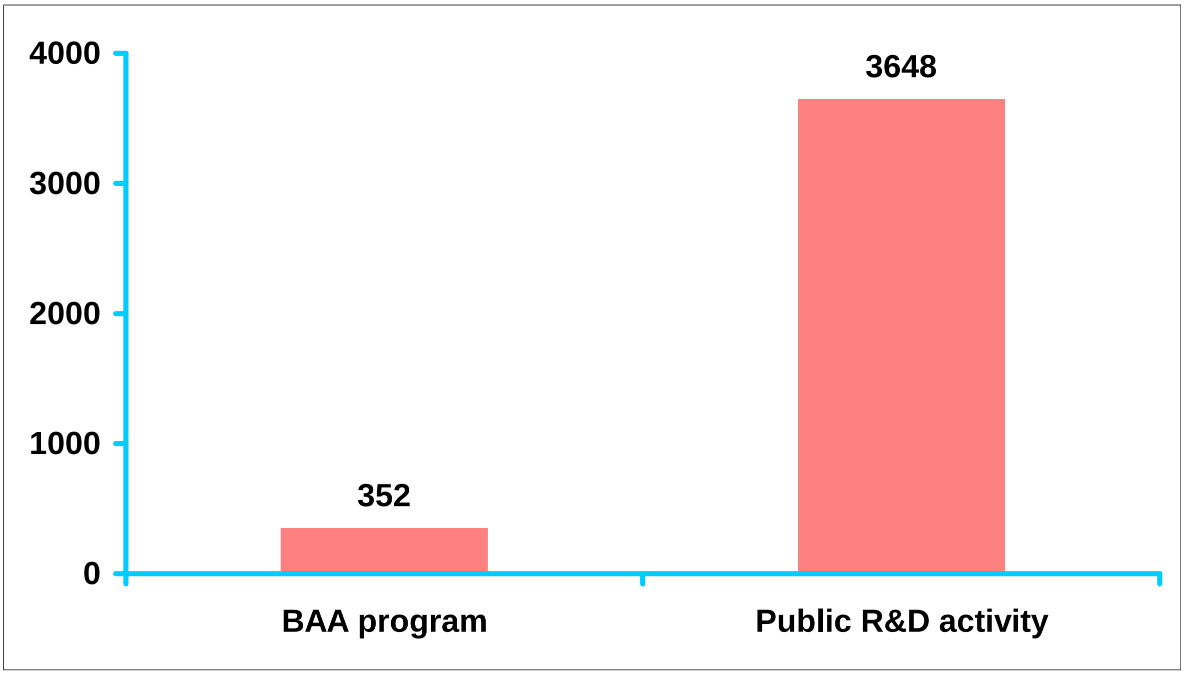
[4] This estimate is based on annual real GDP figures for the 2004/05 year by ABS.
[5] Ibid.
[6] This estimate is based on annual export figures for the 2004/05 year by ABS.
[7] This estimate is based on annual import figures for the 2004/05 year by ABS.

million of exports in 2004/05, 2005 prices)[8], compared with an increase in imports of around 0.94 per cent per annum (equivalent to about $1,775 million of imports in 2004/05, 2005 prices)[9].

The estimates in Chart A also show the net effect of the BAA program and public R&D activity as a whole on investment. In both the BAA Scenario and the Public R&D Scenario, investment is higher than under their corresponding Baseline Scenario. As mentioned before, this increase in investment is part of the general expansion of the economy stemming from higher productivity.

Chart B shows the effects on consumer living standard of the BAA program and public R&D activity as a whole, in terms of the absolute impacts over the long run. In the past, when analysing the impacts of a policy change on the national economy, the traditional focus has been on using GDP to measure the impact on living standards. However, for this report, the effect of an increase in productivity on Australian living standards has been extended to include a measure of annual consumer welfare. In broad terms, annual consumer welfare measures average annual real consumption per head of population.

Chart B
Annual Consumer Living Standard Effects
($ million, 2005 prices, deviations from the Baseline Scenarios)



Source: Econtech MM600+

Using consumption as the measure of living standards instead of GDP is standard practice at the Productivity Commission. Moreover, it has long been the standard practice of Econtech because living standards derive from consumption, not GDP, so in principle, consumption is a more appropriate measure of changes in living standards than GDP.

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8 This estimate is based on annual export figures for the 2004/05 year by ABS.
9 This estimate is based on annual import figures for the 2004/05 year by ABS.

As mentioned before, consumption is affected both for the benefits and the costs of the R&D activity. The benefits take the form of higher productivity that is passed on to consumers in the form of lower prices. This translates into higher real consumption. The costs take the form of higher taxes. With income tax higher than otherwise, consumer spending is lower because private consumption is diverted to government consumption to pay for R&D activities. Given that the benefits of R&D are higher than the costs, the net effect is an increase in consumption.

Chart B shows that the BAA program produces a net annual increase of $352 million (2005 prices) in consumer living standards. Further, the chart shows that public R&D activity as a whole increases consumer living standards by $3,648 million (2005 prices) annually. These net increases in living standards are the result of productivity gains stemming from R&D activity.

Finally, Chart C presents the average annual net wider industry production effects of the BAA program and R&D public activity as a whole. While most industries gain, Chart C shows that the biggest gains are concentrated in the agriculture industry, the education industry, and the property and business services industry (which includes scientific research).

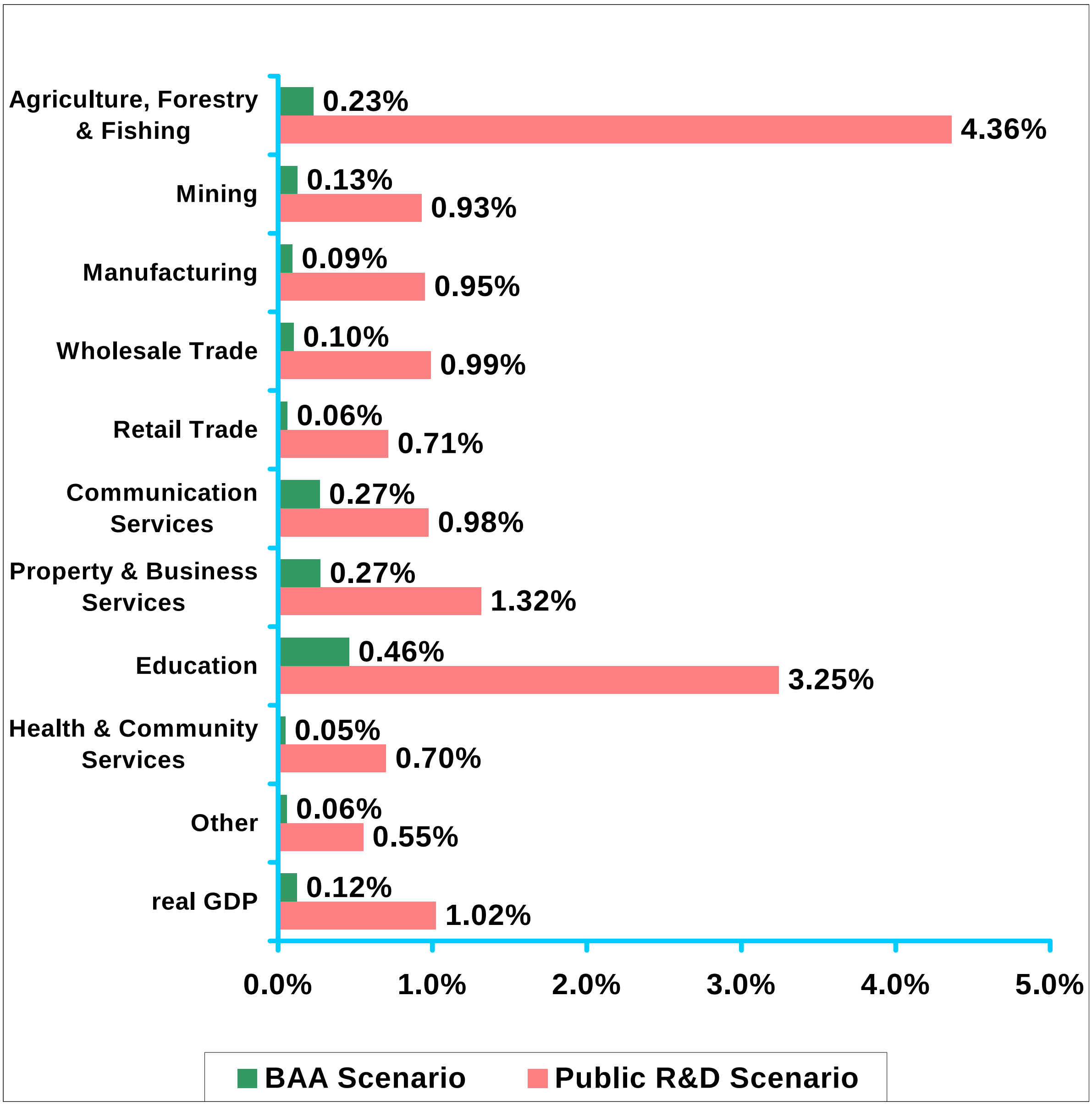
The overall increase in production of the agriculture, education, and the property and business services industries consist of two direct contributions. The first contribution to these industries is an increase in labour productivity stemming from R&D activity. The second contribution is an increase in government funds allocated to these industries.

The industry that shows the biggest production impacts is the agriculture industry. Under the BAA Scenario, the agriculture industry shows an annual increase in production of about 0.23 per cent per annum when compared to the BAA Baseline Scenario. Also, under the Public R&D Scenario the production in this industry is 4.36 per cent higher than under the Public R&D Baseline Scenario. This production effect is mainly caused by a significant boost in productivity. The productivity gains in this industry are particularly high due to two factors. First, a significant part of the R&D funds is allocated to programs that carry out research that benefits the agricultural sector. Second, the internal rate of return to agricultural research is quite high, (30 per cent per annum -real).

The education industry also shows significant production effects. Under the BAA Scenario, the education industry shows an increase in production of about 0.46 per cent per annum, when compared to the BAA Baseline Scenario. Also, under the Public R&D Scenario, production in this sector is 3.25 per cent higher than under the Public R&D Baseline Scenario. This increase in production in the education sector is mainly caused by an increase in government spending, which boosts the production of this industry. In fact, the percentage of funds allocated to the education industry under the Public R&D Scenario is more than 50 per cent of the total Australian Government support for science and innovation. Similarly, the percentage of funds allocated to the education industry under the BAA Scenario is 44 per cent.

Finally, under the BAA Scenario, the property and business services industry shows a 0.27 per cent annual increase in production when compared to the BAA Baseline Scenario. Under the Public R&D Scenario, this effect is 1.32 per cent when compared to the Public R&D Baseline Scenario. The production effect in this industry is mainly fuelled by the scientific research sector which receives a big part of the productivity gains and the funds of the property and business services industry. Indeed, under the Public R&D Scenario, the scientific research sector receives a boost in productivity of 10.51 per cent and receives 18.5 per cent of the public R&D funds.

Chart C
Net Average Annual Wider Industry Production Effects
(% deviations from baseline)



Source: Econtech MM600+

Policy Implications

The results presented in this report demonstrate that public R&D activity, and in particular the BAA program, have substantial impacts on productivity and bring important economic benefits to the Australian economy.

Continued advances in R&D and technology are crucial to ensuring and increasing economic growth. The evidence presented in this report indicates that investments in research and development have large payoffs in terms of productivity, economic growth and living standards. Therefore, it is important that these contributions are taken into account during the policy making process.

1. Introduction

The Productivity Commission is undertaking a research study into the returns of public support for science and innovation in Australia. This public support has been notably augmented in recent years. *Backing Australia's Ability – Building our Future through Science and Innovation,* is a package announced by the Prime Minister on 6 May 2004 totalling $5.3 billion over seven years from 2004/05 and builds on the initial 2001 *Backing Australia's Ability* (BAA) funding of $3 billion over five years to 2005/06. Together, these two packages constitute a $8.3 billion integrated 10-year commitment to science and innovation.

The Department of Education, Science and Training (DEST) is preparing a submission for the Productivity Commission inquiry and commissioned Econtech to model the economic benefits of public funding of research and development (R&D), using the BAA as an illustration. Nonetheless, Econtech has not been able to obtained detailed BAA information from the DEST. In the absence of this information, we have attempted to assess the economic benefits of the BAA program using national and international literature on the returns to publicly funded R&D.

This report is structured as follows.

- Section 2 presents an overview of the BAA program.
- Section 3 presents a literature review of the economic impacts of publicly and privately financed R&D.
- Section 4 outlines the methodology used to simulate the impacts of the BAA program and the public R&D activity as a whole.
- Section 5 evaluates the economic impact of the BAA.
- Section 6 evaluates the economic impact of public R&D activity.
- Section 7 describes the policy implications of the results presented in Section 5 and 6.
- Section 8 presents the references used to prepare this report.

While all care, skill and consideration has been used in the preparation of this report, the findings refer to the terms of reference of the Department of Education, Science and Training and are designed to be used only for the specific purpose set out below. If you believe that your terms of reference are different from those set out below, or you wish to use this work or information contained within it for another purpose, please contact us.

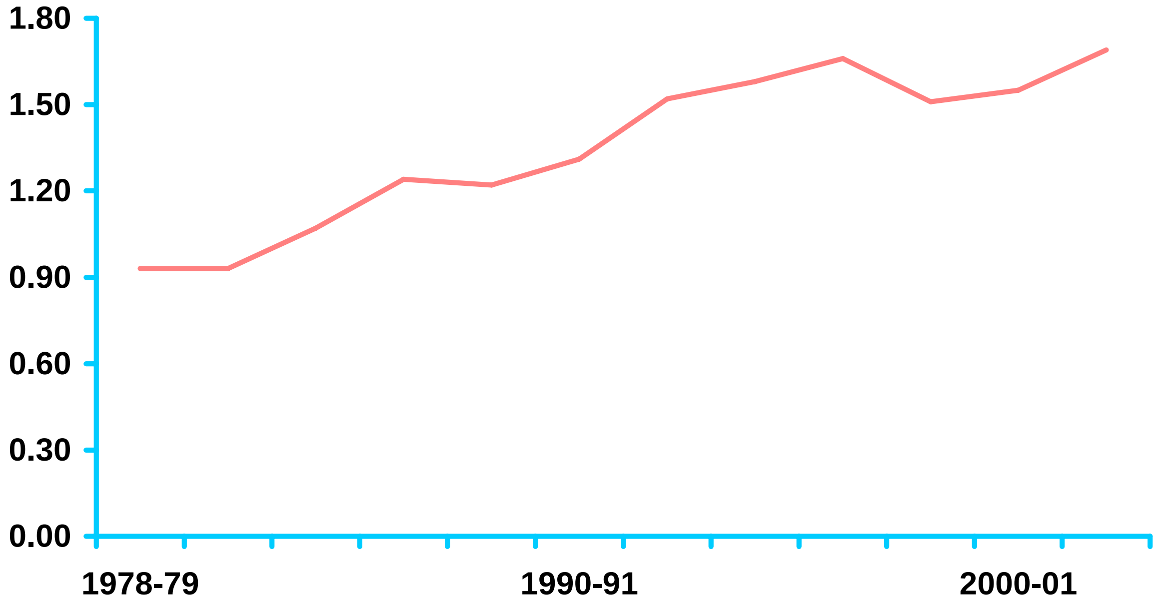
The specific purpose of this report is to assess the economic impact of public funding of R&D, using BAA as an illustration.

The findings in this report are subject to unavoidable statistical variation. While all care has been taken to ensure that the statistical variation is kept to a minimum, care should be used whenever using this information. This report only takes into account information available to Econtech up to the date of this report and so its findings may be affected by new information. Should you require clarification of any material, please contact us.

2. Overview of the BAA

Australia's research and development expenditure is not high compared with international standards. In 2002, Australia spent around 1.69 per cent of gross domestic product (GDP) on research and development[10], below the averages of 2.25 per cent for the OECD as a whole and 1.95 per cent for the European Union (EU)[11]. Nonetheless, this research and development support has been notably augmented over the years. Chart 2.1 shows that Australia's gross domestic expenditure on research and development (GERD) as a percentage of GDP has generally been growing since the 1970's. Furthermore, over the period 1992-2002, Australia increased its GERD measured as a share of GDP by 0.17 percentage points, compared to 0.08 percentage points for the OECD as a whole and the EU[12].

Chart 2.1
Australia's gross domestic expenditure on R&D as a percentage of GDP, 1978-79 to 2002-03.



Source: Department of Education, Science and Training, "Australian Science and Innovation System, a Statistical Snapshot 2005".

In 2001, recognizing the need to further invest in systems that support the creation and development of new ideas in order to generate sustainable economic growth, the Commonwealth government introduced an innovative program, *Backing Australia's Ability* (BAA).

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[10] This figure includes public and private expenditure on R&D.
[11] Department of Education, Science and Training, "*Australian Science and Technology at a glance 2005*"
[12] Ibid.

Backing Australia's Ability is a $3 billion package announced in 2001 to encourage and support science and innovation to enhance Australia's economic prosperity, international competitiveness and social well-being. On May 2004, the Prime Minister announced a new package that builds on the 2001 funding. *Backing Australia's Ability – Building Our Future through Science and Innovation* is a package totalling $5.3 billion over seven years from 2004-05. Together, these packages constitute a ten year, $8.3 billion commitment to science and innovation stretching from 2001-02 to 2010-11.

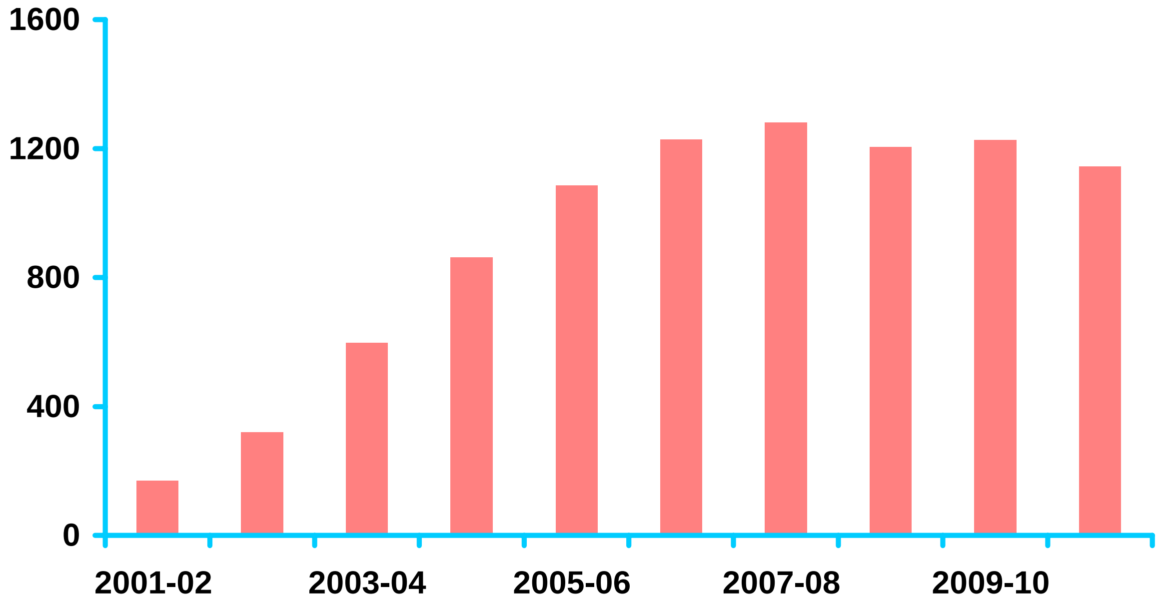
The BAA pursues excellence in research, science and technology, through three key areas:

- research and development;
- commercialization; and
- skills development.

2.1 Resources invested in the BAA

The total funding provided through the combined *Backing Australia's Ability* packages is $8.3 billion over the 10-year period from 2001-02 to 2010-11. Up until 2005, the resources already delivered through BAA program amounted to around $3.04 billion (Chart 2.2).

Chart 2.2
BAA funding 2001-02 to 2010-11 ($ million, current prices)



Source: Figures provided by the Department of Education, Science and Training.

The funds invested in the BAA program represent an important part of the total R&D funds provided by the Commonwealth Government. For instance, the resources invested in the

BAA program in 2005 ($1.09 billion), account for around 20 per cent of the total Australian Government support for science and innovation 2005-06, which was $5.54 billion[13].

The funding provided to the BAA supports many programs and initiatives. Table 2.1 presents a broad description of these programs and the 10 year total amount of funding that each one of them will receive through the BAA.

[13] Department of Education, Science and Training 2005, "*Australian Science and Innovation System, A statistical snapshot*", P. 24.

Table 2.1
BAA Programs

Program	Description	10 year total funding ($m)
Research and development		
National Competitive Grants Program (NCGP)	Supports high quality research, collaborative links, high quality research training, and acquisition and access to equipment and facilities.	$ 2,200.6
Research infrastructure block grants (RIBG)	Provides block grants to eligible higher education providers to remedy deficiencies in current research infrastructure and ensure that areas of recognised research potential have access to the support necessary for development.	$ 895.9
Systemic Infrastructure Initiative (SII)	Provides funding to upgrade systemic infrastructure and support world-class research and research training at Australian universities. SII funds are directed to key areas including the provision of high-speed communications links and facilitating discovery, access and dissemination of scholarly and scientific information.	$ 241.8
Major National Research Facilities (MNRF)	Increases research opportunities by providing better access for Australian researchers to world-class facilities. Facilities funded cover a range of disciplines.	$ 153.2
National Collaborative Research Infrastructure Strategy (NCRIS)	Aims to provide strategic direction for the Australian Government’s investment in major research facilities, supporting infrastructure and networks. NCRIS provides funds to research infrastructure.	$ 541.5
Innovation Access Program – International Science & Technology/International Science Linkages	Comprises a competitive grants program and technology showcasing, innovation access fora and infrastructure support for the Intelligent Manufacturing Systems (IMS) Program. IMS is an industry-led, international research and development program established to develop the next generation of manufacturing and processing technologies.	$ 90.6
Developing Quality and Accessibility Frameworks for Publicly Funded Research	The aim of the research quality framework (RQF) is to improve the assessment of the quality and impact of publicly funded research.	$ 2.8
Extension of Regional Protection Funding	This funding helps protect designated regional higher education providers from losses they incur in the Research Training Scheme (RTS) and the Institutional Grants Scheme (IGS) against their 2001 indexed baseline.	$ 12.5

Program	Description	10 year total funding ($m)
CSIRO National Flagship Program	CSIRO carries out scientific research in areas including energy, information technology, health, minerals, agriculture, the environment and natural resources.	$ 305.0
Health and Medical Research – Overhead Infrastructure Support (NHMRC)	Funds provided for overhead infrastructure costs for independent medical research institutes.	$ 200.0
Extension of the Building on IT Strengths (BITS) Advanced Network Program (ANP)	BITS aims to build the strength and competitiveness of the Australian ICT sector by increasing the rate of new SME formation and developing links and networks between industry participants. BITS is also designed to foster stronger commercialisation linkages with R&D organizations. The ANP helps develop advanced network infrastructure. The program supports the development, trials and demonstration of advanced communications networks, and experimental networks.	$ 21.0
ICT World Class Centre of Excellence	Designed to develop first-class ICT research capabilities in existing and emerging fields, increase the availability of high quality ICT research skills by providing post graduate training and attracting ICT researchers from overseas, and exploit the commercial potential of research outputs.	$ 193.3
Research Support for Counter-Terrorism	Focus on counter-terrorism research. A broad spectrum of activities has been undertaken under the Research Support for Counter-Terrorism program, with a significant increase in counter-terrorism work being undertaken in publicly funded research agencies.	$ 7.2
R&D Tax Concession	The tax concession is a mechanism to encourage private sector expenditure on R&D.	$ 405.1
Commercialisation		
Research and Development (R&D) Start	R&D Start is a merit based grants program which assists Australian companies to undertake R&D and early-stage commercialisation of technological innovation. Most of the funding goes to the information, computer and communication technologies, and applied sciences and technologies areas.	$ 391.14
Innovation Access Program - Industry	Comprises a competitive grants program and technology showcasing, innovation	$ 41.70

Program	Description	10 year total funding ($m)
	access fora and infrastructure support for the Intelligent Manufacturing Systems (IMS) Program.	
Innovation Access Program – Information Technology Online (ITOL)	The ITOL Program encourages collaborative industry-based projects which accelerate the adoption of e-business solutions, and foster awareness and take-up of innovative e-commerce solutions within and across industry sectors. Since 1996 more than $13.3 million has been allocated to 119 innovative projects across a range of industry sectors including agriculture, health and pharmaceutical, building and construction, automotive, viticulture, creative media and mental health services.	$ 13.00
Biotechnology Innovation Fund (BIF)	The BIF is part of the National Biotechnology Strategy and was established in 2001 as a competitive, merit-based grants program to increase the commercialisation of biotechnology. It provides companies with pre-seed, early stage and seed capital to reduce the costs of demonstrating proof of concept between the initial research stage of a biotechnology project and the early stage of its commercialisation.	$ 19.89
Commercial Ready Program	Aims to stimulate greater innovation and productivity growth in the private sector by providing competitive grants to SMEs. The grants help SMEs undertake R&D, proof of concept and early-stage commercialization activities.	$1,168.60
Industry Cooperative Innovation Program	This program supports cooperative industry projects which relate to the development and use of new technologies in industry sectors.	$ 25.00
Commercialising Emerging Technologies (COMET) Program	This program provides firms and individuals with the knowledge and services they need to exploit the commercial potential of innovative activity. Over the life of the program, COMET has helped 162 recipients to form strategic alliances, 34 to enter into joint ventures and 50 into some other form of alliance.	$ 140.00
Biotechnology World Class Centre of Excellence/Extend Support for National Stem Cell Centre	The Australian Stem Cell Centre is a world class biotechnology facility that provides a range of state of the art laboratory capabilities and services for the advancement of stem cell research.	$ 54.40
Refocussing the Cooperative Research Centres (CRC) Program	The CRC program was established to bring together researchers and research users. It emphasises the importance of collaborative arrangements to provide research solutions focused on industry needs. It also has a strong education component with a focus on producing graduates with skills relevant to different industries.	$ 354.51

Program	Description	10 year total funding ($m)
Pre-Seed Fund	This fund seeks to take commercially-promising research and development opportunities at the pre-seed stage within Australian universities, Cooperative Research Centres and Australian Government owned research agencies to the market. It does this through four licensed venture capital funds in which the government and private sector investors invest.	$ 78.70
Extension of the Building on IT Strengths (BITS) Incubator Program	The BITS Incubator Program aims to improve the rate of commercialisation of ICT ideas and R&D by establishing incubators to increase the success rate of new business formation in the sector. Funding provided to incubator managers allows them to help SMEs at a critical stage of their development when they may not be well served by venture capital markets.	$ 36.00
New Industries Development Program (NIDP)	This Program aims to improve Australia's performance in the commercialisation of new, innovative agribusiness products, services and technologies. The program's major focus is the commercialisation of market-driven solutions based on innovation.	$ 32.45
Skills Development		
Questacon Smart Moves	Questacon Smart Moves is designed to raise awareness of science, technology, innovation and related careers in regional and rural secondary schools.	$ 15.06
National Innovation Awareness Strategy/Science Connections Program	The National Innovation Awareness Strategy (NIAS) was announced under BAA to help build a culture that appreciates and rewards science and innovation. The Science Connections Program (SCOPE) is the science awareness component of the NIAS. SCOPE promotes the benefits that science, engineering and innovation bring to Australia.	$ 57.29
Fostering Scientific, Mathematical and Technological Skills and Innovation in Government Schools	Through BAA, the Australian Government is allowing states which trigger the Enrolment Benchmark Adjustment (EBA) to retain their EBA liability for use in government schools to achieve better scientific, mathematical and technological skills, develop school-based innovation, and build supportive school environments.	$1,006.48
2000 University Places	Funding provided for 2 000 additional targeted university places with a priority on mathematics, science and information and communications technology.	$ 364.60

Program	Description	10 year total funding ($m)
Boosting Innovation, Science, Technology and Mathematics Teaching	This component of the BAA helps enhance science, technology and mathematics education and promote innovation in school. The aim is to bring about real and lasting improvements in the ways in which science, mathematics and technology are taught in schools.	$ 38.80
Extend and Enhance National Biotechnology Strategy and Biotechnology Australia	The National Biotechnology Strategy (NBS) was launched in 2000 to provide a framework for capturing the benefits of biotechnology for Australia. In 1999 Biotechnology Australia was established as the coordinating agency for five government departments with biotechnology responsibilities: industry, agriculture, environment, education and science, and health.	$ 20.00
Online Curriculum Content for Schools	Funds committed to support the development of online learning materials and accompanying services and systems for Australian schools.	$ 34.53
Post Graduate Education Loans Scheme (PELS)	The PELS provides loans to eligible students who are enrolled in fee-paying, postgraduate non-research courses. It was designed to remove barriers to national investment in education, training and skills development and increase enrolments in fee-paying postgraduate and non-research courses.	-$ 36.60
Attracting ICT Workers	Immigration initiatives to increase the number of ICT skilled people entering and retained in Australia.	-$ 3.50

Source: Constructed with information from the 2005-06 Australian Government Innovation Report and funding information provided by the Department of Education, Science and Training.

2.2 Recorded achievements of the BAA

It often takes time for the benefits of research to become apparent. Time lags involved in the translation of research into final economic benefits for society may be considerable. These time lags make especially difficult to measure the outcomes or benefits of “young” programs such as the BAA. Therefore, this section only includes an overview of some of the achievements and highlights of the BAA program based on the information provided by the Australian Government’s Innovation Report 2005-06.

Importantly, the BAA supports many programs and initiatives and covers a number of funding arrangements. This means that some programs are only boosted by the BAA but receive support from other sources. Hence, some of the achievements presented in this section relate to outcomes that are not exclusively achieved through the BAA program.

Research and Development

Some of the achievements and highlights of the Research and Development component of the BAA program are:

- CSIRO, Australia’s national science agency, delivers many benefits through its different areas of research. Some of CSIRO’s achievements during 2004-05 include:
  - New contracts were signed with Research and Development Corporations amounting to $44.3 million.
  - Relationships with 40 SMEs were established that generated over $100 000 each in revenue for CSIRO.
  - The spin-off company, Epitactix Pty Ltd, was formed to develop and commercialise novel semiconductor and transistor devices.
  - CeNTIE-2 began – a three-year $23 million co-investment between CSIRO and the Department of Communications, Information Technology and the Arts in advanced networking applications.
  - The intellectual property and equity income value achieved by CSIRO in 2005-06 was $20.4 million. These revenues include running royalties of $15.1 million, and revenues from sales of equity investment and IP through spin-offs of $5.3 million.
- At 30 June 2005, a total of 2 355 companies intended to claim the R&D Tax Offset for the 2003-04 income year and 891 companies intended to claim the 175 per cent Incremental (Premium) R&D Tax Concession for the 2003-04 income year. The R&D Tax Offset claims processed by the Australian Taxation Office in the year ended 30 June 2005, totalled deductions of $717 million; this gave rise to offset amounts of $215 million.
- The grants program R&D Start received a total of 232 applications in 2004-05, and approved 115 for assistance to the value of $121.66 million. The areas that received

the most funding assistance are: information, computer and communication technologies, and applied sciences and technologies areas. Additionally, 120 R&D Start projects were completed in 2004-05 – 77 per cent had results commercialized or which are expected to be commercialized in the near future.

- Under the Australian Research Council's National Competitive Grants Program, Discovery Projects will support approximately 2 750 new and ongoing research projects, representing a commitment of $297.5 million over the five years to 2009. Linkage Projects will support 488 new collaborative research projects and awards worth $115.9 million over the five years to 2009, which will attract $173.0 million in matching contributions in cash and in-kind from partner organisations. Linkage Infrastructure (Equipment and Facilities) approved 78 applications for funding which represented a commitment of $30.4 million.

- During 2004-05, the National Health and Medical Research Council's funding for individual researchers increased by 14 per cent. This included funding for post-graduate and postdoctoral training, early and mid career development and senior researchers.

- The Systemic Infrastructure Initiative will provide $29 million over 2004 to 2006 to enhance Australia's advanced computing, communications and information infrastructure.

- Some of the achievements of the Major National Research Facilities (MNRF) Program during 2004-05 include:

  - Submissions for two joint patents by Gemini and Square Kilometre Array MNRF.

  - Launch of several facilities including the Australian Phenomics Facility, the MNRF Division of the Australian Stem Cell Centre and the Arafura Timor Research Facility.

  - A collaboration agreement between the Australian Computational Earth Systems Simulator (ACcESS) and institutions in Australia, China, Japan and the United States to champion the development of the international Solid Earth Virtual Research Laboratory (iSERVO). The aim of iSERVO is to create a globally accessible computing capability to undertake solid earth simulation from the micro to the global scale.

Commercialization

The BAA's commercialization component has a number of initiatives aimed at increasing access to early stage investment capital. The achievements of some of these initiatives are:

- In December 2004 funding of $407 million was approved for 16 successful Cooperative Research Centre (CRC) applicants, resulting in five new CRCs, nine centres to be developed from existing CRCs, and two CRCs receiving supplementary funding.

- Some of the achievements of the Australian Stem Cell Centre (ASCC) include:
  - At June 2005, the ASCC had selected and provided funds to 15 research projects that met its scientific and commercialisation objectives.
  - By August 2005 the ASCC had awarded a total of eight premier scholarships (up to $25,000 a year) and 10 small research grant scholarships (up to $1,000 a year). It had also provided a number of travel grants and conference awards.
  - In February 2005 the ASCC opened its major national research facility.
- At 30 June 2004, 345 companies were accepted as Building on IT Strengths (BITS) incubatees covering a diverse cross-section of the Information and Communications Technology (ICT) industry including communications hardware and software, business intelligence tools, security and safety, life sciences and biotechnology and e-commerce applications.
- The sixth and final round of the Biotechnology Innovation Fund was announced in May 2004 with a total of 84 applications being considered from 51 companies, most from the health care and agricultural sectors, securing funding worth $11.80 million.
- At 30 June 2005, the Pre-Seed Fund had made 25 investments in 22 companies and three projects in the areas of IT, life sciences, medical devices, agriculture, chemical engineering, environment and manufacturing.
- In 2004-05, the Commercialising Emerging Technologies program (COMET) helped firms raise $54 million in capital, led to 40 alliances or joint ventures, and assisted 33 firms to launch new products.
- The Information Technology Online program (ITOL) funded nine projects to consortium groups involving 50 organisations during 2004-05.
- The New Industries Development Program (NIDP) supported 31 new and 34 continuing Pilot Commercialisation Projects and 16 new and 12 continuing In-Market Experience Scholarships with payments worth more than $3 million during 2004-05.

Skills Development

The skills development component of the BAA has a number of initiatives to stimulate interest in science and innovation and improve the education system. Some highlights of these initiatives are:

- In 2004-05, Questacon Smart Moves travelled to 302 schools in Western Australia, Tasmania and Victoria, as well as northern and central Queensland and the Northern Territory to raise awareness of science, technology, innovation and related careers. Nearly 62 500 students participated in the program over the year.

- The achievements of the Schools Online Curriculum Content Initiative in 2004-05 include:

  - Continuing 16 content development projects in the areas of science, mathematics and numeracy, studies of Australia, languages other than English, literacy for students at risk, innovation, enterprise and creativity. A total of 4 500 learning objects and digital resources will be developed by June 2006.

  - Continuing development of the Schools Online Thesaurus (ScOT) system that describes the subject matter of online content and helps teachers search for content that is suitable for the curriculum requirements of their jurisdiction.

  - Developing the intellectual property rights management system CRISP (Content Rights Information System Project).

  - Involving 30 curriculum expert teachers in content design workshops and educational reviews, and 97 schools, 2 239 students and 97 teachers across Australia and New Zealand in in-school content evaluations.

- In 2005, $91.18 million was allocated under the Australian Postgraduate Awards scheme. In addition, approximately 330 new Endeavour International Postgraduate Research Scholarships (IPRS) were awarded at a cost of $18.1 million.

- Funding of $151 million was provided for 2000 additional targeted university places in 2002 with a priority on mathematics, science and information and communications technology.

- The funding allocated under the Research Training Scheme rose from $540.8 million in 2004 to $552.2 million in 2005.

3. Literature Review

This section reviews and summarizes a selection of studies available in the academic literature on the economic impacts of publicly and privately funded R&D. Whilst being as comprehensive as possible considering the time available for the preparation of this report, the list of studies contained in this review is by no means exhaustive. However, the studies presented in this section provide a useful source of estimated parameters relating to the impact of public support for R&D.

This review includes international and Australian literature on the subject.

3.1 Economic impacts of publicly funded R&D

Much of the econometric literature shows consistent findings of a significant and positive rate of return to publicly funded R&D investments. Martin et al. (1996) present a comprehensive survey of early literature on this field. The authors show that most of the studies in their review reach the same conclusion: that there is a positive and relative high rate of return to R&D investments at the public level. Their literature survey also shows that there is great variation in the estimated rates of return by sector and by study. In spite of this variation, many studies place the economy-wide social rate of return on overall publicly funded research in the order of 25 to 40 per cent a year (e.g. Mansfield et al., 1977; Nadiri, 1993; President's Economic Council of Economic Advisors, 1995; Martin et al., 1996; NIH, 2000; The Allen Consulting Group, 2003).

Additional studies included in a different literature survey, OTA (1986), also report very high internal rates of return on public sector agricultural research. The rate of return varies from 21 per cent to a 100 per cent, with the vast majority of estimates in the 33 to 66 per cent range.

Dowrick (2003) also undertakes a literature review on the rates of return to public R&D carried out in government labs and universities. This review pays particular attention to studies that focus on the relationship between R&D expenditures and productivity growth across countries of the OECD. The estimates on the social rate of return to public R&D presented in Dowrick’s survey range from 5.8 per cent to 8.7 per cent. Nonetheless, the survey indicates that these are under-estimates of the true social rate of return because studies measure the cost savings only for a sub-set of the economy.

A summary of these econometric studies on rate of return to publicly funded R&D is shown in Table 3.1. It shows that the rate of return to publicly funded research varies from 28 to 67 per cent depending on the subject of the study and the methodology. It is important to note that all authors point out that in order to be able to use the results of these studies, it is important to understand the difficulties associated with measuring the economic returns to research and the limits to this approach.

Table 3.1
Published estimates of the rate of return to publicly funded R&D

Author (s)	Subject	Methodology/ Framework [a,b,c,d]	Annual rate of return to public R&D[e]
Griliches (1958)	Hybrid corn	Economic surplus approach	21-40%
Griliches (1964)	Aggregate agricultural research	Production function approach	35-40%
Peterson (1967)	Poultry	Production function approach	21-25%
Evenson (1968)	Aggregate agricultural research	Production function approach	28-47%
Schmitz-Seckler (1970)	Tomato harvester	Economic surplus approach	16-46%
Cline (1975)	Aggregate agricultural research	Production function approach	41-50%
Bredahl and Peterson (1976)	Cash Grain Poultry Dairy Livestock	Production function approach	36% 37% 43% 47%
Knutson and Tweeten (1979)	Aggregate agricultural research	Production function approach	28-47%
Davis (1979)	Aggregate agricultural research	Production function approach	37%
Evenson (1979)	Aggregate agricultural research	Production function approach	45%
Mansfield (1980)	Industrial R&D	Total factor productivity approach	12%
Davis and Peterson (1981)	Aggregate agricultural research	Production function approach	37%
Norton (1981)	Poultry Dairy Livestock Cash grain	Production function approach	27-33% 56-66% 30% 44%

Author (s)	Subject	Methodology/ Framework [a,b,c,d]	Annual rate of return to public R&D[e]
Scobie and Everleens (1986)	Aggregate agricultural research (New Zealand)	Total factor productivity approach	30%
Mansfield (1991)	All academic science research	Return on investment approach	28%
Huffman and Evenson (1993)	Aggregate agricultural research	Production function approach	43-67%
Mullen and Cox (1994)	Agricultural research: broadacre (Australia)	Total factor productivity approach	50-328% [f]
Mullen and Cox (1994)	Agricultural research: broadacre (Australia)	Total factor productivity approach	85-562% [g]
Cockburn and Henderson (2000)	Pharmaceuticals	N/A – study presents a literature review	30% +

Source: Martin et al. (1996), OTA (1986), Masfield (1980), Industry Commission (1995), and Scott et al (2002).

a The economic surplus approach evaluates productivity changes that can be attributed to research. Productivity changes are interpreted as shifts in the supply function.

b The production function approach relies on the estimation of production functions that contain R&D expenditures as an explanatory variable.

c The total factor productivity approach is a variant of the production function approach where instead of relating R&D to output, R&D is related to the growth in total factor productivity (TFP).

d The return of investment approach estimates the rate of return that makes the discounted flow of costs and social benefits of R&D add up to zero.

e Figures in this table are average values.

f Evaluated at 1998 values.

g Evaluated at geometric mean.

While figures in Table 3.1 provide average values, there are other studies in the literature that provide elasticity measures. Guellec and Van Pottelsberghe (2000) quantify the aggregate net effect of government funding on business R&D in 17 OECD countries over the period 1981-96. They found that one dollar of government spending in R&D generates at the margin a 0.70 dollar increase in business-funded R&D when it is direct funding (1.70 in total R&D, i.,e. public + business R&D), a 0.44 dollar reduction when it is spent in government research, and a 0.18 dollar reduction when it is spent in university research. These reductions are less than the initial, one dollar, government expenditure. In other words, total R&D will rise after government has increased its spending: the crowding-out effect of these last two instruments is only partial. These results are averages over the 17 countries (Australia among them).

Other study that provides elasticity measures is Toole (2000). The author investigated the impact of publicly funded basic research on innovation in the pharmaceutical industry. Tooled used a production function framework to model the number of new products as a function of private and public research investment in seven technology classes over the period 1978-1994 for federally funded basic research conducted in the US. The empirical results indicate that a 1 per cent increase in the stock of public basic research ultimately leads to a 2.0 to 2.4 per cent increase in the number of commercially available new compounds after a lag. Toole's results also suggest that the average lag between funding and commercialization is in the range of seventeen to nineteen years.

A summary of these econometric studies that estimate partial elasticities are shown in Table 3.2.

Table 3.2
Published estimates of public R&D elasticities

Author (s)	Subject	Methodology/ Framework [a,b]	R&D elasticity
Guellec and Van Pottelsberghe (2000)	All sectors	Total factor productivity approach	One dollar of public funding for R&D leads to additional business-funded R&D as follows: +$0.70, when allocated to business -$0.44, when allocated to government research -$0.18, when allocated to universities research
Toole (2000)	Pharmaceuticals	Production function approach	A 1 per cent increase in the stock of public basic research leads to a 2 to 2.4 per cent increase in the number of commercially available new compounds.

Source: Guellec and Van Pottelsberghe (2000) and Toole (2000).
a The production function approach relies on the estimation of production functions that contain R&D expenditures as an explanatory variable.
b The total factor productivity approach is a variant of the production function approach where instead of relating R&D to output, R&D is related to the growth in total factor productivity (TFP).

The literature on publicly funded R&D also includes studies that investigate the impact of R&D on productivity. For instance, Guellec and Van Pottelsberghe (2001) investigated the impact of various types of R&D (business R&D, foreign R&D and public R&D) on multifactor productivity growth using a panel of 16 OECD countries. There are three main results from this study. Firstly, authors found that the long-term elasticity of government and university performed research on productivity is 0.17. This means that a 1 per cent increase in public R&D results in a 0.17 per cent increase in productivity growth. Secondly, Guellec and Van Pottelsberghe found that the long-term elasticity of multifactor productivity with respect to business R&D is 0.13. This means that an increase of 1 per cent in business R&D generates a 0.13 per cent in productivity growth. This elasticity effect is larger in countries which are intensive in business R&D, and in countries where the share of defence-related government funding is lower. Finally, authors found that the long-term elasticity of foreign R&D on productivity is 0.46. This means that a 1 per cent increase in foreign R&D generates 0.46 per cent in productivity growth.

In the Australian context, a study was recently conducted to measure the delivered benefits of a major Government R&D funding program in Australia. The Allen Consulting Group's study (2005) makes an assessment of the economic impacts of the Cooperative Research Centres (CRC) Program. The key finding of this study is that over the period 1992-2010, the Australian economy's overall performance has been considerably enhanced when compared to the performance that would have occurred in the absence of the investment on the CRC Program. Over the 1992 to 2010 period, results from the economic impact assessment indicate that gross domestic product, real consumption, real investment and taxation revenues are higher that would have occurred had the money spent on the CRC Program instead gone to general government expenditure. Specifically, GDP is cumulatively (in 2005 dollars) $1,142 million higher, real consumption is cumulatively $763 million higher, real investment is cumulatively $417 million higher, and Commonwealth taxation revenue is cumulatively $66 million higher.

3.2 Economic impacts of privately funded R&D

The core of the empirical literature on R&D comprises studies that estimate the private return to R&D by using data at various levels of aggregation, although most concentrate on the firm or industry level and their results, though not uniform, are the most consistent across studies. These studies seem to form the basis for the consensus that private R&D's contribution to productivity growth is positive and significant. Among such studies, those that employ cross-sectional data show stronger results and more statistical significance than those that use time series data.

COB (2005), presents a comprehensive survey of the empirical literature relating to the productivity effects of private R&D. A summary of cross-sectional studies included in this review that estimate the elasticity of private R&D is shown in Table 3.3. It shows that estimates of the R&D elasticity from these studies vary on the basis of the sample: they range from about 0.05 to 0.60 for studies that used data for individual firms and from zero to 0.50 for studies that used data for industries or sectors. Despite the wide range of estimates, the central tendency runs from about 0.10 to about 0.20[14]. Moreover, the elasticity estimates are statistically significant. These results imply that within an industry, companies that have more R&D capital (or greater R&D intensity[15]) have higher levels of productivity than otherwise similar firms.

Table 3.3
Published estimates of private R&D elasticities from cross- sectional studies

Author (s)	Sample	R&D elasticity *
Minasian (1969)	17 U.S. firms (chemical industry); 1948 to 1957	0.11 - 0.26
Griliches (1980a)	39 U.S. manufacturing industries; 1959 to 1977	0.03 - 0.07
Griliches (1980b)	883 U.S. firms, 1957 to 1965	0.07
Schankerman (1981)	110 U.S. firms (chemical and oil industries); 1963 cross-section	0.10 - 0.16
Sveikauskas and Sveikauskas (1982)	144 U.S. manufacturing industries; 1959 to 1969	0.22 - 0.25

[14] Griliches, Z. 1998, *R&D and Productivity: The Econometric Evidence*, University of Chicago Press.
[15] R&D intensity is R&D expenditure divided by sales.

Author (s)	Sample	R&D elasticity *
Cuneo and Mairesse (1984)	182 French manufacturing firms; 1972 to 1977	0.20
Subsample 1	98 firms in scientific sectors	0.21
Subsample 2	84 firms in non-scientific sectors	0.11
Griliches and Mairesse (1984)		
Sample 1	133 U.S. firms; 1966 to 1977	0.05
Sample 2	77 U.S. firms (scientific sectors); 1966 to 1977	0.19
Griliches (1986)	491 U.S. firms	
Subsample 1	1972 cross-section	0.11
Subsample 2	1977 cross-section	0.09
Jaffe (1986)	432 U.S. firms; 1973 and 1979	0.20
Englander, Evenson, and Hanazaki (1988)	16 industries across six countries; 1970 to 1983	(0.16) - 0.50
Mansfield (1988)	17 Japanese manufacturing industries	0.42
Griliches and Mairesse (1990)		
Sample 1	525 U.S. manufacturing firms; 1973 to 1980	0.25 - 0.41
Sample 2	406 Japanese manufacturing firms; 1973 to 1980	0.20 - 0.56
Hall and Mairesse (1995)	197 French firms; 1980 to 1987	0.05 - 0.25
Wang and Tsai (2003)	136 Taiwanese manufacturing firms; 1994 to 2000	0.19
Hu and Jefferson (2003)	432 Chinese firms; 1991-1997	0.12

Source: CBO (2005) and further additions from Hu and Jefferson (2003)
* Parentheses indicate negative numbers.

In contrast to cross-sectional studies, when researchers use time-series data to estimate the elasticity of R&D they obtain much lower estimates. In fact, with few exceptions, estimates of the R&D elasticity derived from time-series studies lose their statistical significance. A summary of time-series studies that estimate the elasticity of private R&D is shown in Table 3.4.

Table 3.4
Published estimates of private R&D elasticities from time-series studies

Author (s)	Sample	R&D elasticity *
Minasian (1969)	17 U.S. firms; 1948 to 1957	0.08
Griliches (1980b)	883 U.S. firms; 1957 to 1965	0.08

Author (s)	Sample	R&D elasticity *
Cuneo and Mairesse (1984)	182 French manufacturing firms; 1972 to 1977	0.05
Subsample 1	98 firms in scientific sectors	0.14
Subsample 2	84 firms in non-scientific sectors	0.03
Griliches and Lichtenberg (1984b)	27 U.S. manufacturing industries; 1959 to 1976	(0.04)
Griliches and Mairesse (1984)	133 U.S. firms; 1966 to 1977	0.09
Griliches (1986)	652 U.S. firms; 1966 to 1977	0.12
Jaffe (1986)	432 U.S. firms; 1973 and 1979	0.10
Bernstein (1988)	7 Canadian manufacturing industries; 1978 to 1981	0.12
Hall and Mairesse (1995)	197 French firms; 1980 to 1987	0 - 0.07
Verspagen (1995)	14 industries in 11 OECD countries; 1973 to 1988	(0.02) - 0.17

Source: CBO (2005).
* Parentheses indicate negative numbers.

Fewer studies estimate the impact of R&D spending on productivity by using macro-level data (at the national or international level). Many of these studies use cross-sectional data at the national level to analyze the sources of economic growth, but they tend not to focus on R&D spending because the required data are unavailable. Time-series studies are also limited, probably because significant results are hard to come by.

A summary of studies that use macro-level data to estimate the elasticity of private R&D is shown in Table 3.5. It shows that, like the elasticities from the micro-based studies, they span a wide range, from roughly zero to more than 0.60, with a central tendency near 0.10. Several of these authors (Australian Industry Commision 1995; Coe and Helpman 1995; and Patel and Soete, 1988) also remark that the estimates from aggregate data studies are sensitive to the estimating method and to the countries that are included in the data sample.

Table 3.5
Published estimates of private R&D elasticities from studies using aggregated data

Author (s)	Sample/ variable studied	R&D elasticity
Nadiri (1980)	United States; 1949 to 1978 / labour productivity	0.06 - 0.10
Patel and Soete (1988)	United States; 1967 to 1985 / total factor productivity	0.61

Author (s)	Sample/ variable studied	R&D elasticity
Lichtenberg (1992)	98 countries; 1960 to 1985 / per capita output	0.07
Coe and Moghadam (1993)	France; 1971 to 1991 / output	0.17
Coe and Helpman (1995)	G7 countries*; 1971 to 1990 / total factor productivity	0.23
Coe and Helpman (1995)	Non-G7 OECD countries; 1971 to 1990 / / total factor productivity	0.08
Australian Industry Commission (1995)		
Subsample 1	Australia (TFP); 1975 to 1991	0.02
Subsample 2	Australia (output); 1975 to 1991	0.14

Source: CBO (2005).

* The G7 countries are Canada, France, Germany, Italy, Japan, the United Kingdom, and the U.S.

The rate of return to private R&D has also been estimated in several studies. For instance, Medda et al. (2004) studied the relationship between R&D expenditures and productivity growth in the Italian manufacturing industry. The authors investigate the different contributions of various forms of R&D (product, process, internal, external in collaboration with universities, research centres and other firms) to total factor productivity on two different samples (1992-1994 and 1995-1997). The main result of this study is the estimate of the rate of return to private R&D, which is 29 per cent for the 1992-1994 sample and 36.4 per cent for the 1995-1997 sample.

Dowrick (2003) undertook a survey of the rates of return to private R&D commonly found in the literature. While the estimated returns presented in this survey vary widely, the author concludes that business sector investment in R&D may, on average, be privately optimal at the level of the individual firm, consistent with a required rate pre-tax net rate of return of around 20%. Additionally, the author suggests that rates of return are substantially higher at the level of industries, with gross rates of return of up to 40% or more.

COB (2005) also presents a comprehensive survey of studies that estimate the rate of return to private R&D. This survey shows that most of the research papers included in the review estimate a rate of return to R&D that range from zero to nearly 0.60, with a central tendency between 0.20 and 0.30. This wide variation in the estimates arises from subtle differences among studies in the data used or in their specification of the total factor productivity equation. For instance, studies differ in the dependent variable they use (labour productivity or total factor productivity) and how it is calculated. A summary of these studies is presented in Table 3.6.

Table 3.6
Published estimates of the rate of return to private R&D

Author (s)	Sample	Rate of return to R&D*
Terleckyj (1974)	33 U.S. industries; 1948 to 1966	0 - 0.30
Mansfield (1980)	16 U.S. firms (chemical and petroleum industries); 1960 to 1976	0.27
Terleckyj (1980)	20 U.S. manufacturing industries; 1948 to 1966	0.20 - 0.27
Link (1981)		
Subsample 1	174 U.S. firms; 1971 to 1976	0
Subsample 2	33 U.S. firms (chemical industry); 1971 to 1976	0.07
Scherer (1982)	87 U.S. manufacturing industries; 1964 to 1969 and 1973 to 1978	0.13 - 0.29
Griliches and Mairesse (1983)		
Regular sample	343 U.S. and 185 French firms; 1973 to 1978	0.28
Industry dummies	343 U.S. and 185 French firms; 1973 to 1978	0.12
Odagiri (1983)		
Subsample 1	123 Japanese firms (scientific sectors);1969 to 1981	0.26
Subsample 2	247 Japanese firms (other sectors); 1969 to 1981	(0.47)
Clark and Griliches (1984)	924 U.S. manufacturing plants; 1970 to 1980	0.20
Griliches and Lichtenberg (1984a)	193 U.S. manufacturing industries; 1959 to 1978	0.04 - 0.30
Odagiri and Iwata (1986)		
Regular sample	135 Japanese firms; 1966 to 1973	0.20
Industry dummies	135 Japanese firms; 1966 to 1973	0.17
Odagiri and Iwata (1986)		
Regular sample	168 Japanese firms; 1974 to 1982	0.17
Industry dummies	168 Japanese firms; 1974 to 1982	0.11
Mansfield (1988)	17 Japanese industries; 1960 to 1979	0.42
Goto and Suzuki (1989)	40 Japanese manufacturing firms; 1976 to 1984	0.22 - 0.56
Sterlacchini (1989)	15 U.K. manufacturing industries; 1954 to 1984	0.10 - 0.30
Lichtenberg and Siegel (1991)	2,207 U.S. firms; 1972 to 1985	0.13

Author (s)	Sample	Rate of return to R&D*
Griliches (1994)	142 U.S. manufacturing industries; 1958 to 1989	0.12 - 0.46
Hall and Mairesse (1995)	197 French firms; 1980 to 1987	0.06 - 0.34
Jones and Williams (1998)	12 U.S. manufacturing industries; 1961 to 1989	0.35

Source: CBO (2005) and further additions from Medda et al. (2004)
* Parentheses indicate negative numbers.

It is important to note that, although related, the estimates of the rate of return to R&D presented in Table 3.6 are not directly comparable with the elasticity estimates presented in Tables 3.3 and 3.4. The elasticity estimates measure the percentage increase in output that results from a 1 per cent increase in the R&D stock, whereas the rate of return measures the change in output caused by an increase of $1 in the R&D stock. It is not always possible to compute the R&D elasticity from the rate of return (and vice versa) because the relationship depends in part on the estimate of the R&D stock, which differs among studies.

In the Australian context, a study was recently conducted to explore the economic effects of private R&D on Australian productivity (Shanks and Zheng, 2006). The analysis in this study is based in a time series approach rather than in a cross country approach. In this study, Shanks and Zheng present a point estimate of the gross return to Australian business R&D of 50 per cent at the level of the market sector. Nonetheless, authors recognize that this figure is not “precisely estimated”. The study also provides estimates on the rate of return to business R&D at the industry level. Specifically, Shanks and Zheng estimate a return in the manufacturing industry of 50 per cent, in the mining industry of 159 per cent, in the wholesale and retail trade industry of 438 per cent and in the agriculture industry of 24 per cent. Again, the authors warn readers about the robustness of their estimates and point out that these results should be considered only indicative.

4. Modelling approach

This section provides details of the modelling approach used to estimate the economic benefits of the BAA program and the public R&D activity as a whole. As discussed in the introduction, in the absence of detailed information on the costs and benefits of the BAA program, Econtech based its estimates of the benefits of the BAA program on previous national and international research as detailed in the literature review. Furthermore, Econtech only used the BAA funding data proportioned by DEST for the 2001-02 to 2010-11 period to calculate the perpetual benefits of the BAA program. This BAA funding information is presented in Attachment A. Additionally, to be consistent with the BAA analysis, the analysis of the public R&D activity as a whole only models the effects of ten years of funding, from 2001-02 to 2010-11.

This section is structured as follows. Section 4.1 outlines the advantages of Econtech's modelling approach over previous work. Section 4.2 outlines the scenarios that are simulated using MM600+ to quantify the economic contribution of the BAA program and the public R&D activity as a whole. Section 4.3 outlines the main data inputs that Econtech uses to build the three alternative scenarios and describes how these inputs are derived. Section 4.3 discusses the main features of the economic model (MM600+) that is used to estimate the economic contribution of the BAA program and the public R&D activity as a whole.

4.1 Comparison with previous work

As mentioned in Section 3.1, the first attempt to measure the benefits of a major government R&D funding program in Australia was by Allen Consulting Group (2005). This study makes an assessment of the economic impacts of the Cooperative Research Centres (CRC) program.

This Econtech study effectively extends the Allen Consulting Group's results by estimating the actual and future net benefits of the BAA program (including the CRC). There are two important differences between these studies.

- Firstly, this Econtech study includes estimates of the current and future benefits of the BAA (including the CRC). In comparison, in the Allen Consulting Group study, the criteria used to measure the benefits of the CRC program only included the already delivered or apparent benefits (not the forthcoming benefits from past investments in research). That is, benefits in the "pipeline" were excluded from the economic impact assessment. The consequence of this, as recognized by the Allen Consulting Group, is that the study presents only a partial calculation of the benefits delivered by the CRC program.
- Secondly, this Econtech study estimates the net benefit of the BAA (including CRC). The net benefit is defined as the gross benefit less the costs of the program. In comparison, the Allen Consulting Group's excluded the cost of the CRC program. That is, the authors unconventionally assumed that if the Commonwealth had not funded the CRC program, the money would have been allocated across other government expenditure.

4.2 Scenarios

To simulate the economic impacts of the BAA program and the public R&D activity as a whole on the Australian economy, the following four scenarios are modelled:

- The "BAA Baseline Scenario" which reflects a situation where there is no BAA program.
- The "BAA Scenario" which reflects a situation where the BAA exists. This scenario includes the spending and outcomes associated with the BAA program. The levels of spending are taken from the funding information provided by DEST (Attachment A) and the outcomes calculated based on the literature review presented in Section 3.
- The "Public R&D Baseline Scenario" which reflects a situation where there is no public R&D.
- The "Public R&D Scenario". This scenario is modelled to estimate the economic benefits of the public R&D activity as a whole and includes the spending and outcomes associated with the public R&D activity as a whole.

Differences in economic outcomes between the BAA Scenario and the BAA Baseline Scenario are calculated to determine the economic benefits of the BAA program. Similarly, differences in economic outcomes between the Public R&D Scenario and the Public R&D Baseline Scenario are calculated to determine the economic benefits of the public R&D activity in general.

The main inputs for each of the scenarios are discussed in detail below.

4.3 Model Inputs

There are two sets of shocks that Econtech applied to the MM600+ model in each simulation. One set of shocks is related to the benefits of the R&D activity, and the other to its costs.

The benefits of the BAA program and of the public R&D activity as a whole are estimated using information about the allocation of funds to the BAA program and to the public R&D activity, and the rates of return on public R&D investments obtained from the national and international literature. A summary of the literature estimates that are used to produce the shocks to MM600+ is presented in Table 4.1. Based on this information, Econtech estimated the productivity gains in each industry that are introduced into the MM600+. Importantly, the BAA program provides funding for ten years from 2001-02 to 2010-11. Econtech only used the public R&D data for this period to calculate the perpetual benefits of the BAA program. Also, to be consistent with the BAA Scenario, the Public R&D Scenario only models the effects of ten years of funding, from 2001-02 to 2010-11.

As all the modelling in this study is in perpetual terms, the costs of the BAA program and of the public R&D activity as a whole were calculated as a perpetuity using a 5 per cent discount rate. This discount rate reflects the cost of funding for the government, which is the real interest rate of government bonds.

Table 4.1
Literature estimates used to produce the shocks to MM600+

Source	Input	Estimate
Scobie and Everleens (1986)	Rate of return to public agricultural research (New Zealand)	30% (real)
Mansfield (1991)	Rate of return to public academic science research	28% (real)
Cockburn and Henderson (2000)	Rate of return to public research on Pharmaceuticals	30% (nominal)
Various [a]	Rate of return to overall public R&D	25-40% (real)
OECD (2005)[b]	Social internal rate of return to investment in education for an individual obtaining an upper secondary or post-secondary non-tertiary education from a lower upper secondary level of education (assuming the individual immediately acquires the next higher level of education). Conservative US rate for male/female (2002).	20% (real)
OECD (2005) [b]	Social internal rate of return to investment in education for an individual obtaining a university-level degree from an upper secondary and post-secondary non-tertiary level of education (assuming the individual immediately acquires the next higher level of education). Conservative US rate for male/female (2002).	10% (real)

Source: Industry Commission (1995), Mansfield (1991), Scott et al (2002), and OECD (2005).
a As mentioned in Section 3.1, several studies place the economy-wide social rate of return on overall publicly funded research in the order of 25 to 40 per cent a year (e.g. Mansfield et al., 1977; Nadiri, I., 1993; President's Economic Council of Economic Advisors, 1995; Martin et al., 1996; NIH, 2000; The Allen Consulting Group, 2003).
b Estimates on the social rate of return to investment in education will be used to calculate the returns to some of the funds invested in the "skills development" part of the BAA program.

Importantly, the exogenous shocks associated with the removal of the CRC program from Allen Consulting Group (2005) have not been included in the BAA Scenario. This is because, given the two points raised in Section 4.1, the Allen Consulting Group's approach to modelling the economic impact of CRCs might result in an underestimation of the benefits of the program. To further confirm this, Econtech used the exogenous shocks associated with the removal of the CRC program included in the Allen Consulting Group's study (Attachment B) to calculate the internal rate of return on the funds invested in the program. The result was an internal rate of return of about 4.7 per cent. This extremely low rate of return on investment confirms that Allen's study presents only a partial calculation of the benefits derived by the CRC program. Therefore, instead of using the information included in Allen Consulting Group's study about the benefits of the CRC program, we calculated the benefits of the CRC program in the same way we calculated the benefits of all the other BAA programs.

Inputs for the BAA Scenario

Using the BAA funding tables contained in Attachment A and the rates of return on public R&D investment from Table 4.1, Econtech estimated the productivity shocks that are introduced into the MM600+. A detailed description of the process followed to estimate the MM600+ inputs used in the BAA Scenario is presented in Box 4.1. A summary of the inputs used to shock the MM600+ under the BAA Scenario is presented in Table 4.3

Box 4.1 Steps used to produce MM600+ inputs for the BAA Scenario

Steps to derive the inputs used in the MM600+ model:

1. The BAA funds assigned to each program (Attachment A) were converted into 1998/99 prices, because MM600+ is based on the 1998/99 values. Also, the estimates in Table 4.1 that were in nominal terms were converted to real terms by using an inflation rate of 2.5 per cent per annum.

2. *Allocation of funds.* Based on Table 2.1 and on public information available on each of the programs included in the BAA, the funds presented in Attachment A were allocated to the sectors or industries that receive those funds (e.g. education, scientific research, health, etc). This information is used in the BAA Scenario to boost government spending on R&D in those sectors. As all the modelling in this study is in perpetual terms, these costs of the BAA program (i.e. the government spending on the BAA) were calculated as a perpetuity using a 5 per cent discount rate. This discount rate reflects the cost of the public R&D funding, which is the real interest rate of government bonds.

3. *Allocation of benefits.* Based on Table 2.1, on Section 2.2 and on public information available on each of the programs included in the BAA, we identified the industries that would benefit (or are likely to benefit) from the BAA's different programs. When a program benefits more than one industry, it is assumed that each industry benefits equally from the program (i.e. the benefits are equally split among industries). For instance, CSIRO carries out scientific research in areas including energy, information technology, health, minerals, agriculture, the environment and natural resources. Hence, the benefits derived from CSIRO research are equally divided among these industries/sectors.

   When, due to limited information, the benefits of a program could not be traced to a particular industry, we did the following. First, we assumed that the funds of this particular program will be spent in different research areas following a pattern similar to the government intramural expenditure on R&D (GOVERD) by economic objective (Table 4.2). Hence, from the 100 per cent of the funds of a particular program we assigned 20.5 per cent of the funds to environment, 11.4 per cent of the funds to defence, etc. Second, we identified the industries that would benefit from the funds spent in each of these economic objectives.

Continues in page 28…

Continuation of Box 4.1

4. *Estimation of benefits (returns).* The returns to the funds invested in each of the BAA programs (i.e. the cost savings achieved through the R&D investment) were calculated by industry, using the internal rate of return estimates presented in Table 4.1. When detailed information about a program was available, the more specific estimates in Table 4.1 were used. For instance, if a program supports agricultural research, then the rate of return to agricultural research presented in Table 4.1 (30 per cent) was used. When it was not possible to identify a particular type of R&D due to information restrictions, an overall public R&D rate of return of 25 per cent was used[16].

   For this calculation it was assumed that the cost savings will be achieved one year after the investment in R&D is made and that these cost savings will continue to be accrued annually thereafter. Importantly, in this study Econtech only models the benefits or returns of ten years of spending on research and development. Therefore, considering the potential time lags involved in the translation of research into final economic impacts, the estimates of the economy-wide impacts of the BAA presented in this report are conservative.

5. *Conversion of the cost savings into labour efficiencies.* The cost savings calculated in step 4 can be viewed as an improvement in labour efficiency (the same amount of output can be produced with less input –labour-). The transformation of these labour cost savings into labour efficiencies was done as follows. First, we calculated the labour cost savings per year as a percentage of the costs of labour input in each of the industries (for this calculation it was assumed that the real growth of the economy is 3 per cent per annum). Second, we calculated the net present value of all future labour cost savings. Third, we converted this present value to equivalent labour constant savings in perpetuity, that is, we calculated the perpetual benefits of the R&D activity. This is the average labour efficiency (productivity gain) that is used as input to the MM600+ model. All these calculations are done by industry.

Source: Econtech

Table 4.2
Government intramural expenditure on R&D (GOVERD) by economic objective

Objective	% of GOVERD (2002-03)
Environment	20.5%
Plant products & plant primary products	15.2%
Defence	11.4%
Animal products & animal primary products	11.2%
Manufacturing	9.4%
Health	9.2%
Economic framework	5.5%
Mineral resources (excl. energy)	3.9%

[16] Although several studies place the economy-wide social rate of return on overall publicly funded research on the order of 25 to 40 per cent a year, we will use a conservative estimate of 25 per cent to avoid overestimation of the benefits.

Objective	% of GOVERD (2002-03)
Social development and communication services	2.4%
Energy resources	2.4%
Information and communication services	2.1%
Non-oriented research	2.0%
Construction	1.5%
Commercial services and tourism	1.1%
Energy supply	1.1%
Transport	0.6%
Education and training	0.5%

Source: Department of Education, Science and Training, "Australian Science and Innovation System. A statistical snapshot 2005". Pg. 103

Table 4.3
MM600+ Inputs for BAA Scenario

Industry	Labour efficiencies (%)
Scientific research, technical and computer services	1.52%
Education	0.25%
Sport, gambling and recreational services	0.04%
Services to agriculture; hunting and trapping	0.14%
Photographic and scientific equipment	0.56%
Road transport	0.02%
Residential building construction	0.04%
Rail, pipeline and other transport	0.03%
Medicinal and pharmaceutical products; pesticides	0.39%
Petroleum and Coal products	0.20%
Other food products	0.08%
Other construction	0.002%
Other agriculture	0.10%
Non-ferrous metal ores	0.26%
Meat and meat products	1.31%
Accommodation, cafes and restaurants	0.01%
Coal; oil and gas	0.15%
Communication services	1.04%
Community services	0.10%
Defence	0.57%
Electricity supply	0.09%
Electronic equipment	0.66%
Forestry and logging	0.53%
Government Administration	0.20%
Grains	0.29%
Health services	0.02%
Iron ores	0.61%
Sheep	0.41%
Beef cattle	0.27%
Dairy cattle	0.48%
Pigs	2.80%
Poultry	0.86%
Services to agriculture; hunting and trapping	0.76%
Commercial fishing	0.86%

Other mining	0.61%
Dairy products	0.11%
Fruit and vegetable products	0.07%
Oils and fats	0.72%
Flour mill products and cereal foods	0.19%
Bakery products	0.09%
Confectionery	0.11%
Soft drinks, cordials and syrups	0.12%
Beer and malt	0.25%
Wine and spirits	0.16%
Tobacco products	0.23%
Textile fibres, yarns and woven fabrics	0.07%
Textile products	0.09%
Knitting mill products	0.17%
Clothing	0.04%
Footwear	0.19%
Leather and leather products	0.38%
Saw logs and dressed timber	0.08%
Other wood products	0.04%
Pulp, paper and paperboard	0.10%
Paper containers and products	0.05%
Printing and services to printing	0.02%
Publishing; recorded media and publishing	0.02%
Basic chemicals	0.04%
Paints	0.14%
Soap and detergents	0.19%
Cosmetics and toiletry preparations	0.20%
Other chemical products	0.11%
Rubber products	0.08%
Plastic products	0.06%
Glass and glass products	0.11%
Ceramic products	0.10%
Cement, lime and concrete slurry	0.11%
Plaster and other concrete products	0.08%
Other non-metallic mineral products	0.17%
Iron and steel	0.04%
Basic non-ferrous metal and products	0.02%
Structural metal products	0.03%
Sheet metal products	0.04%
Fabricated metal products	0.02%
Motor vehicles and parts; other transport equipment	0.01%
Ships and boats	0.17%
Railway equipment	0.13%
Household appliances	0.06%
Other electrical equipment	0.07%
Agricultural, mining and construction machinery; lifting and material handling equipment	0.04%
Other machinery and equipment	0.03%
Furniture	0.03%
Other manufacturing	0.09%
Banking	0.01%
Water supply; sewerage and drainage services	0.04%

Source: Econtech

Inputs for the Public R&D Scenario

The labour efficiency shocks (productivity gains) introduced into the MM600+ to model the Public R&D Scenario were calculated using the same methodology presented in Box 4.1, and using the following assumptions:

- *Period of study*. To be consistent with the BAA Scenario, the Public R&D Scenario will only model the effects of ten years of funding, from 2001-02 to 2010-11.

- *R&D funding*. The funds allocated to the public R&D are calculated using the information about the Australian Government support for science and innovation as a percentage of GDP[17] and GDP values expressed in 98/99 dollars. The GDP values for the period from 2006-07 to 2010-11 were estimated using a growth rate of the economy of 3 per cent per annum. Additionally, it is assumed that the Australian Government support for science and innovation as a percentage of GDP for the period from 2006-07 to 2010-11 remains in the 2005-06 level (0.60 per cent of GDP). The total funds allocated to public R&D activity by year are presented in Table 4.4.

Table 4.4 Funds allocated to public R&D activity as a whole from 2001-02 to 2009-11 (98-99 dollars, $ million)

Year	Australian Gvt support for science and innovation as a percentage of GDP	GDP (98/99 dlls, $m)	Public R&D (98/99 dlls, $ m)
2001-02	0.64%	$ 617,719	$ 3,953
2002-03	0.62%	$ 639,577	$ 3,965
2003-04	0.64%	$ 664,792	$ 4,255
2004-05	0.62%	$ 694,930	$ 4,309
2005-06	0.60%	$ 717,939	$ 4,308
2006-07	0.60%	$ 739,477	$ 4,437
2007-08	0.60%	$ 761,662	$ 4,570
2008-09	0.60%	$ 784,512	$ 4,707
2009-10	0.60%	$ 808,047	$ 4,848
2010-11	0.60%	$ 832,288	$ 4,994

Source: ABS, DEST "Australian Science and Technology at a glance 2005", and Econtech estimates.

- *Allocation of funds.* The public R&D funds were allocated to the sectors or industries that receive those funds using the information presented in Table 4.5 about the distribution of Australian Government support for science and innovation by portfolio. This information is used in the Public R&D Scenario to boost government spending in those sectors.

Table 4.5 Distribution of Australian Government support for science and innovation- by portfolio, budget estimates for 2005-06.

Portfolio	Government support for science and innovation (percentage)
Environment and Heritage	3.32%

[17] Department of Education, Science and Training, "*Australian Science and Technology at a glance 2005*" Pg. 10.

Portfolio	Government support for science and innovation (percentage)
Industry, Tourism and Resources	18.5%
Health and Aging	7.8%
Communications, IT and the Arts	0.78%
Transport and Regional Services	0.04%
Agriculture, Fisheries and Forestry	4.15%
Defence	5.95%
Prime Minister and Cabinet	0.04%
Education, Science and Training	59.42%

Source: Department of Education, Science and Training, "Australian Science and Innovation System. A statistical snapshot 2005". Pg. 25

- *Allocation of benefits.* The allocation of benefits was done by following the same methodology used to produce the inputs for the the BAA Scenario. First, it is assumed that the funds will be spent in different research areas following a pattern similar to the government intramural expenditure on R&D (GOVERD) by economic objective (Table 4.2). Second, we identified the industries that would benefit from the funds spent in each of these economic objectives.

A summary of the inputs used to shock the MM600+ under the Public R&D Scenario is presented in Table 4.6

Table 4.6
MM600+ Inputs for Public R&D Scenario

Industry	Labour efficiencies (%)
Scientific research, technical and computer services	10.51%
Education	0.07%
Sport, gambling and recreational services	0.79%
Photographic and scientific equipment	1.26%
Road transport	0.38%
Residential building construction	0.30%
Petroleum and Coal products	1.34%
Other food products	0.54%
Other construction	0.19%
Other agriculture	1.60%
Non-ferrous metal ores	3.46%
Meat and meat products	24.35%
Accommodation, cafes and restaurants	0.21%
Coal; oil and gas	2.04%
Communication services	1.22%
Community services	1.89%
Defence	10.76%
Electricity supply	1.75%
Electronic equipment	0.81%
Forestry and logging	8.06%
Government Administration	3.63%
Grains	4.40%
Iron ores	8.08%

Sheep	7.48%
Beef cattle	4.97%
Dairy cattle	8.69%
Pigs	51.08%
Poultry	15.67%
Services to agriculture; hunting and trapping	13.84%
Commercial fishing	13.68%
Other mining	11.57%
Dairy products	0.90%
Fruit and vegetable products	1.32%
Oils and fats	5.66%
Flour mill products and cereal foods	1.52%
Bakery products	0.67%
Confectionery	2.15%
Soft drinks, cordials and syrups	2.28%
Beer and malt	1.97%
Wine and spirits	2.98%
Tobacco products	4.41%
Textile fibres, yarns and woven fabrics	1.26%
Textile products	1.74%
Knitting mill products	3.32%
Clothing	0.84%
Footwear	3.55%
Leather and leather products	7.27%
Saw logs and dressed timber	1.56%
Other wood products	0.74%
Pulp, paper and paperboard	1.91%
Paper containers and products	0.90%
Printing and services to printing	0.31%
Publishing; recorded media and publishing	0.32%
Basic chemicals	0.74%
Paints	2.59%
Soap and detergents	3.70%
Cosmetics and toiletry preparations	3.73%
Other chemical products	2.13%
Rubber products	1.56%
Plastic products	0.48%
Glass and glass products	2.11%
Ceramic products	1.81%
Cement, lime and concrete slurry	2.01%
Plaster and other concrete products	1.49%
Other non-metallic mineral products	3.17%
Iron and steel	0.34%
Basic non-ferrous metal and products	0.44%
Structural metal products	0.57%
Sheet metal products	0.83%
Fabricated metal products	0.43%
Motor vehicles and parts; other transport equipment	0.26%
Ships and boats	1.32%
Railway equipment	2.44%
Household appliances	1.10%
Other electrical equipment	0.58%
Agricultural, mining and construction machinery; lifting and material handling equipment	0.72%

Other machinery and equipment	0.49%
Furniture	0.49%
Other manufacturing	1.77%

Source: Econtech

4.4 MM600+ Model

The economy-wide contributions of the R&D activity, in particular of the BAA program, were estimated using the MM600+ model.

MM600+ is a long-term computable general equilibrium (CGE) model of the Australian economy that models a long-run equilibrium (approximately 5 to 10 years). It distinguishes 108 industries that produce 672 products, making it six times more detailed than any comparable model. The industry and production classification used in MM600+ is based on Australian and New Zealand Standard Industry Classifications (ANZSIC) used by the Australian Bureau of Statistics (ABS).

MM600+ has the following important features that make it well suited for the analysis in this report.

- It estimates the effects of policy changes on key macroeconomic aggregates such as GDP, exports, imports, consumption and investment.
- It breaks down the effects of policy changes into 108 industries and 672 products. This means that the model is able to estimate the impacts of public R&D activity across industries and products.
- For each industry and product, it produces comprehensive results including for production, employment, consumption, trade flows and prices.
- It provides valid measures of changes in consumer welfare or living standards based on compensating and equivalent variations so that policy changes can be correctly evaluated in terms of the public interest.

The alternative scenarios modelled in this report are based on the standard long-run closure of the MM600+ model. Thus, the long-run closure shows the long-term effects of policy changes, after the economy has fully responded. This is fitting because economic policies should be judged against their lasting effects on the economy, not just their effects in the first one or two years. Some of the assumptions underlying the MM600+ long-term closure are as follows:

- Profit maximisation: the representative business in each industry chooses inputs and outputs to maximise profit subject to prices and a production function exhibiting constant returns to scale.
- Labour market equilibrium: in the long-run the labour market is assumed to attain equilibrium, so that an economic shock has no lasting effect on total employment.
- External trade balance: in the long-run, external balance is assumed to be achieved, so that trade shocks have no lasting effect on the trade balance.
- Budget balance: in the long-run fiscal policy must be sustainable, and in MM600+ this is achieved by assuming budget balance.
- Private saving: in the long-run the level of private sector saving and associated asset accumulation must be sustainable.

More detailed information about MM600+ is presented in Attachment C.

5. Economic Impact of the BAA

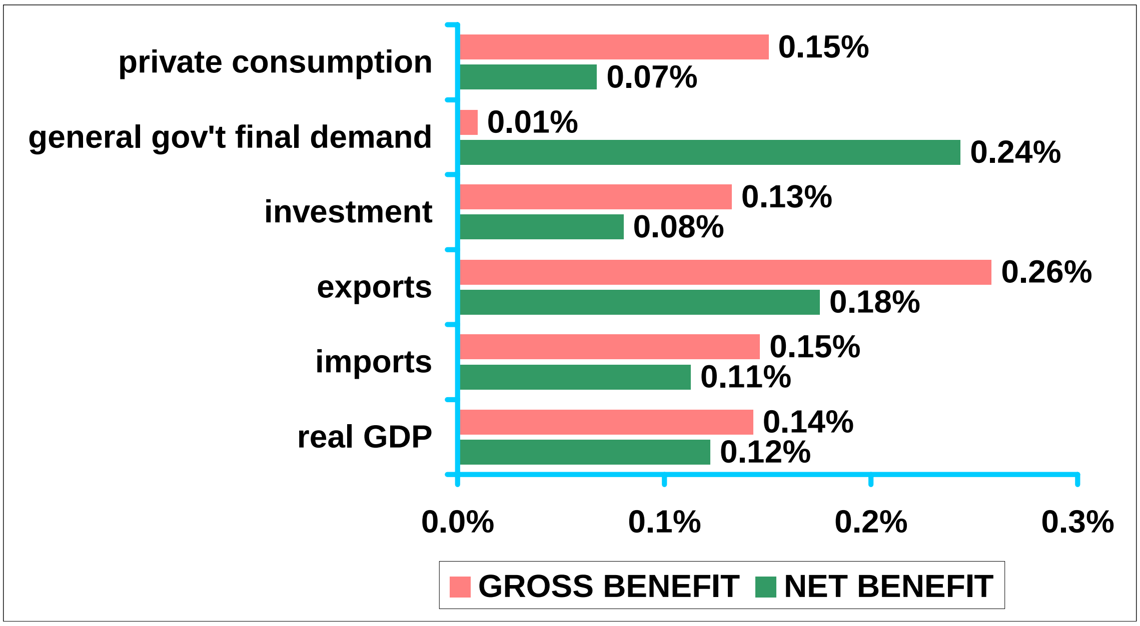
Section 4 described the scenarios that were simulated using MM600+, outlined the main data inputs that Econtech used to build the scenarios and described how these inputs were derived. This section provides estimates of the average annual economy-wide contributions of the BAA program. Section 5.1 describes the economy-wide economic impacts of the BAA program. Section 5.2 describes the industry-specific impacts of the BAA program.

5.1 National Effects

This section provides estimates of the average annual economy-wide contributions of the BAA program. As mentioned before, this involves estimating the economic contributions of two alternative scenarios, the BAA Scenario and the BAA Baseline Scenario. The difference in economic outcomes between these two scenarios determines the economic benefits of the BAA program.

Chart 5.1 shows the gross and net benefits of the BAA program. The gross benefits only include the effect of an increase in labour productivity on the economy, while the net benefits include the increase in labour productivity *and* the cost of the BAA program (i.e. the increase in government spending). This is the reason why, in general, the net benefits are lower than the gross benefits.

Chart 5.1
National Macro-economic Effects
(% deviation from baseline)



Source: Econtech MM600+

The net effect of the BAA program on private consumption includes two impacts. The first impact comes from the cost of the R&D activity. The BAA program represents an increase in government spending. In this study, it is assumed that this increase in government spending is funded by income tax being higher than otherwise. With income tax higher than otherwise, consumer spending is lower because private consumption is diverted to government consumption to pay for the program. The second impact on private consumption comes from the benefits of the R&D activity. In the long run, the effect of higher productivity in industries is passed on to consumers in the form of lower prices for consumer goods and services. Lower consumer prices arising from the productivity growth translate into higher real private consumption. Since the benefits of the R&D activity are higher than the costs, Chart 5.1 shows a net improvement in private consumption under the BAA Scenario of 0.07 per cent per annum when compared to the BAA Baseline Scenario.

In the past, when analysing the impacts of a policy change on the national economy, the traditional focus has been on using GDP to measure the impact on living standards. However, it has long been the standard practice of Econtech to use consumption as the measure of living standards instead of GDP. This is a better measure because living standards derive from consumption, not GDP, so in principle, consumption is a more appropriate measure of changes in living standards than GDP. Therefore, the best single measure of the BAA impact on living standards is private consumption.

Chart 5.1 also shows the net and gross impacts of the BAA program on government consumption, investment, exports, imports and GDP. This chart shows that the gross real GDP is 0.14 per cent higher than under the BAA Baseline Scenario. This percentage represents the growth in GDP attributable to productivity gains and it is reduced when the costs of the BAA program are included in the model to calculate the net benefits of the BAA. The chart shows that the net real increase in GDP under the BAA Scenario is 0.12 per cent when compared to the BAA Baseline Scenario. That is, the productivity gains achieved through the BAA program lead to a net long-term increase in GDP of 0.12 per cent per annum, when compared to the BAA Baseline Scenario. This is equivalent to about $1,072 million of real GDP in 2004/05 (2005 prices)[18].

The productivity gains achieved through the BAA program lead to an expansion of the Australian economy as a whole, including the levels of exports, imports and investment (*all other things being equal*). To accept these additional exports, the world market would ask for a lower price. Therefore, to maintain the external balance, export volumes need to rise more than import volumes. Indeed, Chart 5.1 shows that exports increase more than imports under the BAA Scenario. Specifically, exports are higher by 0.18 per cent (equivalent to about $296 million of exports in 2004/05, 2005 prices)[19] while imports increase by only 0.11 per cent (equivalent to about $208 million of imports in 2004/05, 2005 prices)[20], when compared to the BAA Baseline Scenario.

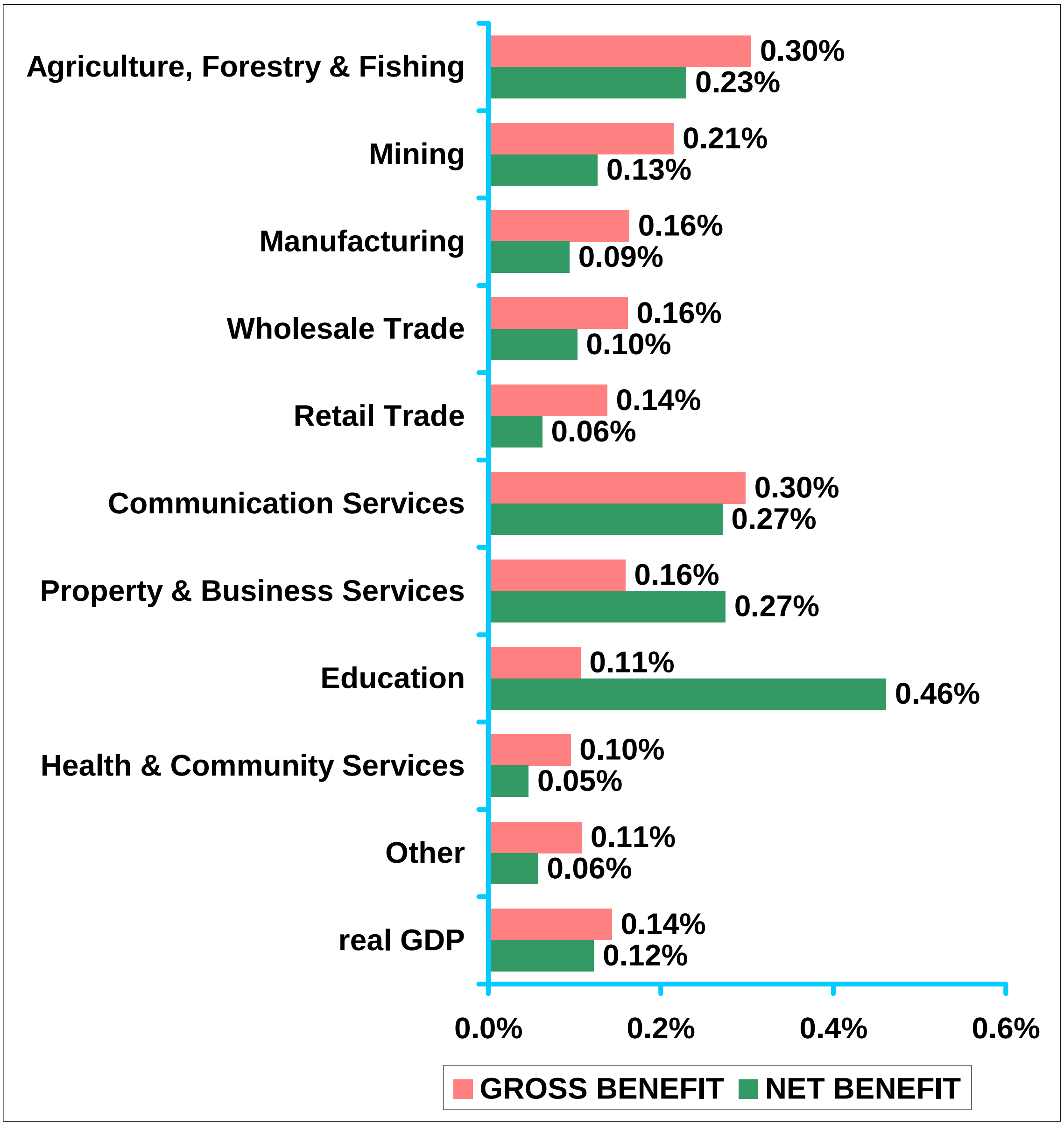
The estimates in Chart 5.1 also show the net effects of the BAA program on investment. The chart shows that investment is 0.08 higher under the BAA Scenario, than under the BAA Baseline Scenario. This is equivalent to about $96.11 million of real private business investment in 2004/05 (2005 prices)[21].As mentioned before, this increase in investment is part of the general expansion of the economy stemming from higher productivity.

[18] This estimate is based on annual real GDP figures for the 2004/05 year by ABS.
[19] This estimate is based on annual export figures for the 2004/05 year by ABS.
[20] This estimate is based on annual import figures for the 2004/05 year by ABS.
[21] This estimate is based on annual private business investment figures for the 2004/05 year by ABS.

5.2 Industry Effects

This section shows the average annual wider industry effects of the BAA program. The average annual gross and net wider industry production effects are shown in Chart 5.2. The gross industry production effects shown in this chart reflect the growth in production that is attributable to productivity gains achieved through the BAA program. In contrast, the net industry production effects shown in Chart 5.2 reflect the growth in production after including the productivity gains in the industry *and* the costs of the BAA program. This is why, in almost all cases, the net benefit is lower than the gross benefit.

Chart 5.2
Average Annual Wider Industry Production Effects
(% deviations from baseline)



Source: Econtech MM600+

Chart 5.2 shows that, while most industries gain, the biggest gains are concentrated in the education, communication services, property and business services (which includes scientific research), and the agriculture industries. The overall increase in production of these industries consists of two direct contributions. The first contribution of the BAA program to these industries is an increase in labour productivity. The second contribution of the BAA program to these industries is an increase of government funds allocated to these industries.

As shown in Chart 5.2, the gross increase in production in the education industry is 0.11 per cent annually, when compared to the BAA Baseline Scenario. This figure only reflects the productivity gains achieved through the BAA program. Importantly, this gross benefit is smaller than the net benefit. This is because the increase in production caused by a boost in government spending in the education sector is bigger than the increase in production stemming from productivity gains. Government spending is particularly high is this sector because many of the BAA programs include a skills development component and assign a significant amount of funds to the education sector. This results in a net increase in production in the education sector of 0.46 per cent per annum when compared to the BAA Baseline Scenario.

The communication services industry shows a 0.27 per cent net increase in production when compared to the BAA Baseline Scenario. The production effect in this industry is mainly caused by the productivity gains achieved through the BAA program. The productivity effect in this industry is quite high because many of BAA programs are targeted to the information and communications technology (ICT) sector.

Similarly to the education industry, the net effect in the property and business sector industry is bigger than the gross effect. The gross increase production in this industry is 0.16 per cent annually, when compared to the BAA Baseline Scenario. This means that the productivity gains achieved through the BAA program increase production in the property and business industry (which includes scientific research) by 0.16 per cent per annum. In contrast, the net effect is an increase in production of 0.27 per cent annually. This net effect is bigger than the gross effect because the increase in production caused by a boost in government spending in the scientific research sector is bigger than the increase in production stemming from productivity gains. Government spending is particularly high is this industry because many of the BAA programs are targeted to the scientific research sector.

Finally, the agriculture industry shows an increase of 0.23 per cent per annum when compared to the BAA Baseline Scenario. This production effect is mainly caused by a significant boost in productivity. The productivity gains in this industry are particularly high due to two factors. First, a significant part of the BAA funds is allocated to programs that carry out research that benefits the agricultural sector. Second, the internal rate of return to agricultural research is quite high, (30 per cent per annum -real).

Based on the results presented in this section, we can conclude that the general effect of having the BAA program versus not having the BAA program is an improvement in consumer living standards. This means that, while the BAA represents a cost to consumers because it is supported by taxes, the benefits of the program greatly outweigh its costs and result in a net improvement on the standards of living of Australian consumers. Furthermore, the results in this section show that the BAA program contributes to the overall expansion of the Australian economy by increasing the productivity of industries.

6. Economic impact of public R&D activity

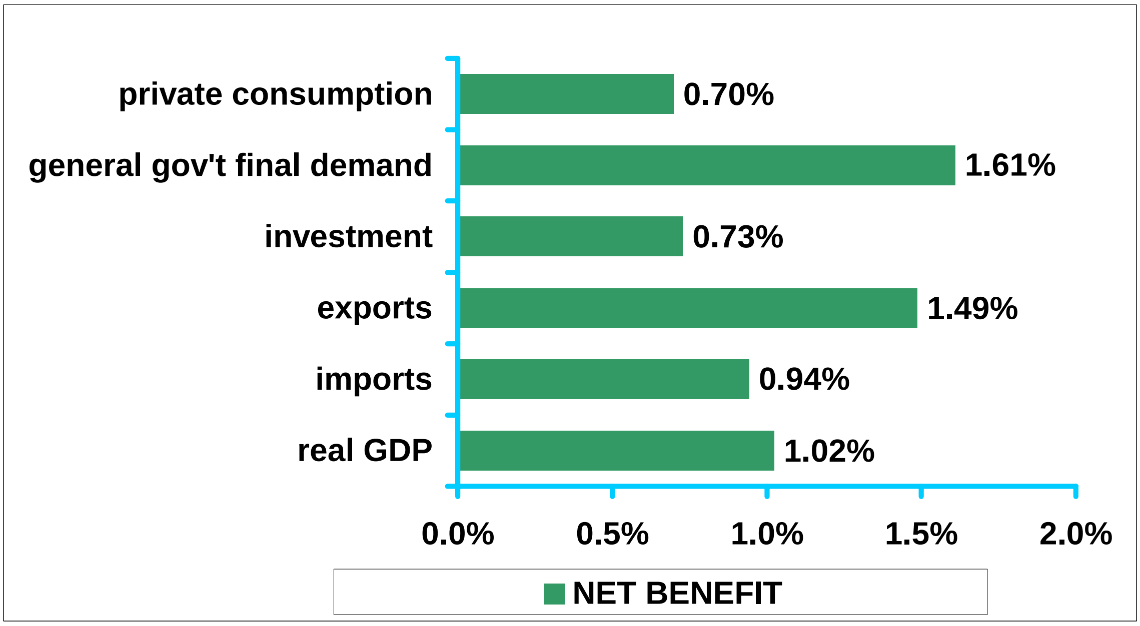
Section 5 described the economic impacts of the BAA program, both at national and industry levels. This section provides estimates of the contribution to the economy of public R&D activity as a whole. Section 6.1 describes the economy-wide economic impacts of public R&D activity as a whole. Section 6.2 describes the industry-specific impacts of public R&D activity as a whole.

6.1 National Effects

This section provides estimates of the average annual economy-wide contributions of the R&D activity as a whole. As mentioned before, this involves estimating the economic contributions of two alternative scenarios, the Public R&D Baseline Scenario and the Public R&D Scenario. The difference in economic outcomes between the Public R&D Scenario and the Public R&D Baseline Scenario determines the economic benefits of the public R&D activity as a whole.

Chart 6.1 shows the main average annual national macroeconomic effects of the public R&D activity as a whole. These effects are the *net* benefits of the public R&D activity. Therefore, these benefits include the increase in labour productivity achieved through the R&D activity *and* the cost of the R&D (i.e. the increase in government spending).

Chart 6.1
National Macro-economic Effects
(% deviation from baseline)



Source: Econtech MM600+

The chart shows the general effects of having public R&D activity versus not having public R&D activity. Specifically, the chart shows that public R&D activity increases private consumption in 0.70 per cent per annum. As mentioned before, private consumption is affected both for the benefits and the costs of the R&D activity. The benefits take the form of higher productivity that is passed on to consumers in the form of lower prices. This translates into higher real consumption. The costs take the form of higher taxes. With income tax higher than otherwise, consumer spending is lower because private consumption is diverted to government consumption to pay for R&D activities. Given that the benefits of R&D are higher than the costs, the net effect is an increase in private consumption.

Further, Chart 6.1 shows that real GDP is 1.02 per cent higher than under the Public R&D Baseline Scenario. That is, the productivity gains achieved through public R&D activity lead to a long-term increase in GDP of 1.02 per cent per annum, when compared to the Public R&D Baseline Scenario. This is equivalent to about $9,116 million of real GDP in 2004/05 (2005 prices)[22].

Similarly to the BAA program scenario, the productivity gains stemming from the public R&D activity lead to an expansion of the Australian economy as a whole, including the level of exports, imports and investment (*all other things being equal*). To accept these additional exports, the world market would ask for a lower price. Therefore, to maintain the external balance, export volumes need to rise more than import volumes. Indeed, Chart 6.1 shows that exports increase more than imports under the Public R&D Scenario. Specifically, when compared to the Public R&D Baseline Scenario, exports are higher by 1.49 per cent (equivalent to about $2,449 million of exports in 2004/05, 2005 prices)[23] while imports increase by only 0.94 per cent (equivalent to about $1,775 million of imports in 2004/05, 2005 prices)[24].

Chart 6.1 also shows the net effects of the public R&D activity on investment. The chart shows that investment is 0.73 per cent higher under the Public R&D Scenario, than under the Public R&D Baseline Scenario. This is equivalent to about $877 million of real private business investment in 2004/05 (2005 prices)[25].This increase in investment is part of the general expansion of the economy stemming from higher productivity.

In comparison with the macroeconomic effects of the BAA program, the economy-wide effects of public R&D activity are much bigger. For instance, the long term annual increase in real GDP under the BAA Scenario is 0.12 per cent, in contrast to 1.02 per cent under the Public R&D Scenario. This is a logic result since the BAA program is just a small part of the budget assigned to R&D activity in Australia.

Finally, Chart 6.2 shows the effects on consumer living standard of the BAA program and the public R&D activity as a whole, in terms of the absolute impacts over the long run. In the past, when analysing the impacts of a policy change on the national economy, the traditional focus has been on using GDP to measure the impact on living standards. However, for this report, the effect of an increase in productivity on Australian living standards has been extended to include a measure of annual consumer welfare. In broad terms, annual consumer welfare measures average annual real consumption per head of population.

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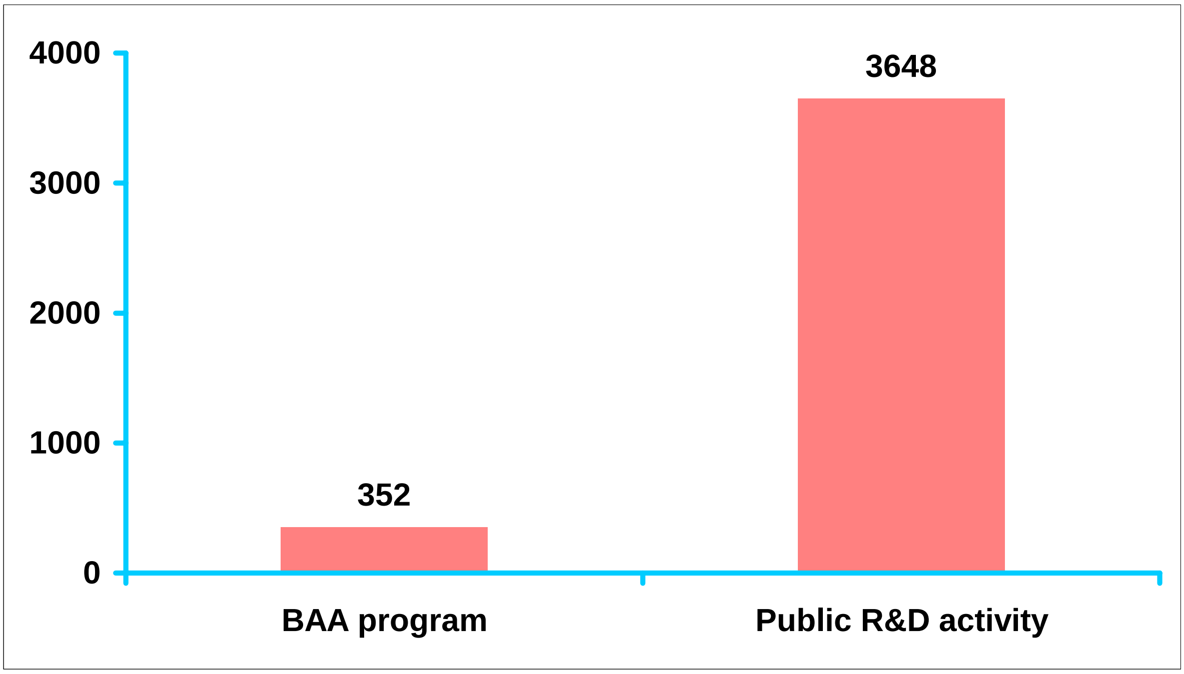
[22] This estimate is based on annual real GDP figures for the 2004/05 year by ABS.
[23] This estimate is based on annual export figures for the 2004/05 year by ABS.
[24] This estimate is based on annual import figures for the 2004/05 year by ABS.
[25] This estimate is based on annual private business investment figures for the 2004/05 year by ABS.

Using consumption as the measure of living standards instead of GDP is standard practice at the Productivity Commission. Moreover, it has long been the standard practice of Econtech because living standards derive from consumption, not GDP, so in principle, consumption is a more appropriate measure of changes in living standards than GDP.

Chart 6.2 shows that the BAA program produces a net annual increase of $352 million (2005 prices) in consumer living standards. Further, the chart shows that public R&D activity as a whole increases consumer living standards by $3,648 million (2005 prices) annually. These net increases in living standards are the result of productivity gains stemming from R&D activity.

Chart 6.2
Annual Consumer Living Standard Effects
($ million, 2005 prices, deviations from the Baseline Scenarios)



Source: Econtech MM600+

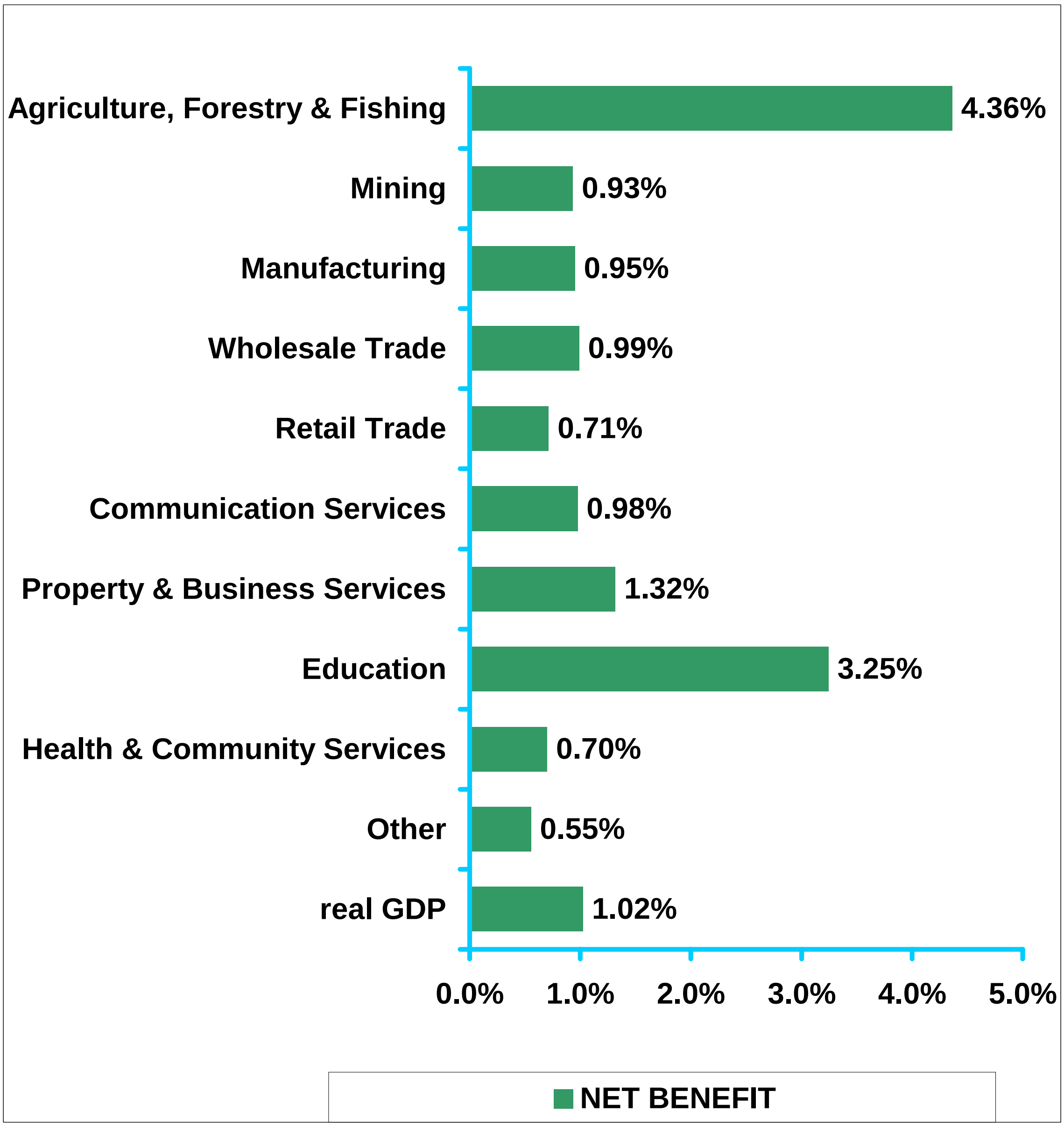
6.2 Industry Effects

This section presents the estimated impact of the R&D public activity as a whole on different industries. The average annual wider industry production effects are shown in Chart 6.3.

In general, all industries included in Chart 6.3 show increases in average annual production when compared to the Public R&D Baseline Scenario. Similarly to the BAA Scenario, the industries that benefit the most from publicly funded R&D activity are the agriculture, education, and property and business services industries (which includes scientific research).

The industries that show the biggest production impacts are the agriculture and the education industries. The agriculture industry shows an annual increase in production of about 4.36 per cent per annum when compared to the Public R&D Baseline Scenario. This production effect is mainly caused by a significant boost in productivity. The productivity gains in this industry are particularly high due to two factors. First, a significant part of the BAA funds is allocated to programs that carry out research that benefits the agricultural sector. Second, the internal rate of return to agricultural research is quite high, (30 per cent per annum -real).

Chart 6.3
Average Annual Wider Industry Production Effects
(% deviations from baseline)



Source: Econtech MM600+

The education industry also shows significant production effects. Under the Public R&D Scenario, production in this sector is 3.25 per cent higher than under the Public R&D Baseline Scenario. This increase in production in the education sector is mainly caused by an increase in government spending, which boosts the production of this industry. In fact, the percentage of funds allocated to the education industry under the Public R&D Scenario is more than 50 per cent of the total Australian Government support for science and innovation (Table 4.5).

Finally, the property and business services industry shows a 1.32 per cent annual increase in production when compared to the Public R&D Baseline Scenario. The production effect in this industry is mainly fuelled by the scientific research sector which receives a big part of the productivity gains and the funds of the property and business services industry. Indeed, under the Public R&D Scenario, the scientific research sector receives a boost in productivity of 10.51 per cent and receives 18.5 per cent of the public R&D funds.

7. Policy Implications

The results presented in this report demonstrate that public R&D activity, and in particular the BAA program, have substantial impacts on productivity and bring important economic benefits to the Australian economy.

Continued advances in R&D and technology are crucial to ensuring and increasing economic growth. The evidence presented in this report indicates that investments in research and development have large payoffs in terms of productivity, economic growth and living standards. Therefore, it is important that these contributions are taken into account during the policy making process.

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Attachment A – BAA's Funding Overview

Backing Australia's Ability (BAA) 10 Year Funding Table - Current Expenditures and Forward Estimates as at May 2006 (a) (b) (c)

PROGRAMME			2001-02 ($m) Actual	2002-03 ($m) Actual	2003-04 ($m) Actual	2004-05 ($m) Actual	2005-06 ($m) Estimated Actual	2006-07 ($m) Budget Estimate	2007-08 ($m) Forward Estimate	2008-09 ($m) Forward Estimate	2009-10 ($m) Forward Estimate	2010-11 ($m) Forward Estimate	BAA-II 5 Year Total ($m)	BAAI + BAAII 7 Year Total ($m)	10 Year Total ($m)	Notes
RESEARCH AND DEVELOPMENT																
National Competitive Grants Programme (NCGP)	BAA + BAA-BOFTSI	Admin.	19.200	92.500	142.800	204.400	274.500	272.900	284.500	293.700	299.600	305.600	1,456.300	1,935.200	2,189.700	d
		Dept.	0.000	0.000	0.000	0.592	0.581	0.581	2.284	2.284	2.284	2.284	9.717	10.890	10.890	
		Total	**19.200**	**92.500**	**142.800**	**204.992**	**275.081**	**273.481**	**286.784**	**295.984**	**301.884**	**307.884**	**1,466.017**	**1,946.090**	**2,200.590**	
Research Infrastructure Block Grants (RIBG)	BAA + BAA-BOFTSI	Admin.	26.900	47.957	69.185	89.942	105.101	107.203	109.240	111.315	113.430	115.585	556.773	751.816	895.858	
		Dept.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
		Total	**26.900**	**47.957**	**69.185**	**89.942**	**105.101**	**107.203**	**109.240**	**111.315**	**113.430**	**115.585**	**556.773**	**751.816**	**895.858**	
Systemic Infrastructure Initiative (SII)	BAA	Admin.	23.612	28.432	71.400	39.898	61.400	17.100	0.000	0.000	0.000	0.000	17.100	118.398	241.842	e, u
		Dept.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
		Total	**23.612**	**28.432**	**71.400**	**39.898**	**61.400**	**17.100**	**0.000**	**0.000**	**0.000**	**0.000**	**17.100**	**118.398**	**241.842**	
Major National Research Facilities (MNRF)	BAA	Admin.	5.100	25.033	38.520	42.259	42.308	0.000	0.000	0.000	0.000	0.000	0.000	84.567	153.220	e
		Dept.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
		Total	**5.100**	**25.033**	**38.520**	**42.259**	**42.308**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**84.567**	**153.220**	
National Collaborative Research Infrastructure Strategy	BAA-BOFTSI	Admin.	0.000	0.000	0.000	0.000	13.151	98.196	100.400	102.499	104.694	106.985	512.774	525.925	525.925	e
		Dept.	0.000	0.000	0.000	1.891	2.043	2.244	2.287	2.333	2.379	2.427	11.670	15.604	15.604	
		Total	**0.000**	**0.000**	**0.000**	**1.891**	**15.194**	**100.440**	**102.687**	**104.832**	**107.073**	**109.412**	**524.444**	**541.529**	**541.529**	
Innovation Access Programme - International Science & Technology/International Science Linkages	BAA + BAA-BOFTSI	Admin.	0.000	7.645	7.595	9.307	10.190	9.589	9.917	10.134	10.455	10.775	50.870	70.367	85.607	s
		Dept.	0.000	0.000	0.000	0.000	0.000	0.969	0.976	1.000	1.025	1.051	5.021	5.021	5.021	
		Total	**0.000**	**7.645**	**7.595**	**9.307**	**10.190**	**10.558**	**10.893**	**11.134**	**11.480**	**11.826**	**55.891**	**75.388**	**90.628**	
Developing Quality and Accessibility Frameworks for Publicly Funded Research	BAA-BOFTSI	Admin.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
		Dept.	0.000	0.000	0.000	1.114	1.661	0.000	0.000	0.000	0.000	0.000	0.000	2.775	2.775	
		Total	**0.000**	**0.000**	**0.000**	**1.114**	**1.661**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**2.775**	**2.775**	
Extension of Regional Protection Funding	BAA-BOFTSI	Admin.	0.000	0.000	0.000	3.029	3.086	3.148	3.208	0.000	0.000	0.000	6.356	12.471	12.471	f
		Dept.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
		Total	**0.000**	**0.000**	**0.000**	**3.029**	**3.086**	**3.148**	**3.208**	**0.000**	**0.000**	**0.000**	**6.356**	**12.471**	**12.471**	
CSIRO National Flagship Programme	BAA-BOFTSI	Admin.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
		Dept.	0.000	0.000	0.000	30.000	35.000	40.000	50.000	50.000	50.000	50.000	240.000	305.000	305.000	
		Total	**0.000**	**0.000**	**0.000**	**30.000**	**35.000**	**40.000**	**50.000**	**50.000**	**50.000**	**50.000**	**240.000**	**305.000**	**305.000**	
Health and Medical Research - Overhead Infrastructure Support (NHMRC)	BAA-BOFTSI	Admin.	0.000	0.000	0.000	24.200	27.000	28.000	29.000	30.000	30.000	30.000	147.000	198.200	198.200	
		Dept.	0.000	0.000	0.000	1.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.800	1.800	
		Total	**0.000**	**0.000**	**0.000**	**26.000**	**27.000**	**28.000**	**29.000**	**30.000**	**30.000**	**30.000**	**147.000**	**200.000**	**200.000**	
Extension of the Building on IT Strengths (BITS) Advanced Network Programme (ANP)	BAA-BOFTSI	Admin.	0.000	0.000	0.000	8.000	7.038	5.004	0.000	0.000	0.000	0.000	5.004	20.042	20.042	f
		Dept.	0.000	0.000	0.000	0.302	0.273	0.374	0.000	0.000	0.000	0.000	0.374	0.949	0.949	
		Total	**0.000**	**0.000**	**0.000**	**8.302**	**7.311**	**5.378**	**0.000**	**0.000**	**0.000**	**0.000**	**5.378**	**20.991**	**20.991**	
ICT World Class Centre of Excellence	BAA + BAA-BOFTSI	Admin.	0.000	10.300	11.300	17.200	23.500	23.970	24.449	24.938	25.437	25.946	124.740	165.440	187.040	g
		Dept.	1.500	1.500	0.700	0.500	0.500	0.266	0.355	0.365	0.292	0.302	1.580	2.580	6.280	
		Total	**1.500**	**11.800**	**12.000**	**17.700**	**24.000**	**24.236**	**24.804**	**25.303**	**25.729**	**26.248**	**126.320**	**168.020**	**193.320**	
Research Support for Counter-Terrorism	BAA-BOFTSI	Admin.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	d
		Dept.	0.000	0.000	0.000	1.000	2.000	2.100	2.100	0.000	0.000	0.000	4.200	7.200	7.200	
		Total	**0.000**	**0.000**	**0.000**	**1.000**	**2.000**	**2.100**	**2.100**	**0.000**	**0.000**	**0.000**	**4.200**	**7.200**	**7.200**	
R&D Tax Concession - New Elements Continued	BAA + BAA-BOFTSI	125%	-25.000	-95.000	-115.000	-95.000	-95.000									i
		175% Premium	20.000	55.000	90.000	90.000	100.000	105.000	115.000	70.000	80.000	90.000	460.000	467.390	404.520	
		175% (Dept.)	0.980	2.840	3.310	3.460	3.930									
		R&D Tax Offset (Dept.)	0.000	0.240	0.140	0.110	0.110	0.000	0.000	0.000	0.000	0.000	0.000	0.220	0.600	
		Total	**-4.020**	**-36.920**	**-21.550**	**-1.430**	**9.040**	**105.000**	**115.000**	**70.000**	**80.000**	**90.000**	**460.000**	**467.610**	**405.120**	

Backing Australia's Ability (BAA) 10 Year Funding Table - Current Expenditures and Forward Estimates as at May 2006 (a) (b) (c)

PROGRAMME			2001-02 ($m) Actual	2002-03 ($m) Actual	2003-04 ($m) Actual	2004-05 ($m) Actual	2005-06 ($m) Estimated Actual	2006-07 ($m) Budget Estimate	2007-08 ($m) Forward Estimate	2008-09 ($m) Forward Estimate	2009-10 ($m) Forward Estimate	2010-11 ($m) Forward Estimate	BAA-II 5 Year Total ($m)	BAAI + BAAII 7 Year Total ($m)	10 Year Total ($m)	Notes
COMMERCIALISATION																
Research and Development (R&D) Start	BAA	Admin.	17.500	30.500	89.698	90.812	119.628	0.000	0.000	0.000	0.000	0.000	0.000	210.440	348.138	j
		Dept.	0.000	3.400	9.460	14.030	16.110	0.000	0.000	0.000	0.000	0.000	0.000	30.140	43.000	
		Total	**17.500**	**33.900**	**99.158**	**104.842**	**135.738**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**240.580**	**391.138**	
Innovation Access Programme - Industry	BAA	Admin.	0.000	6.617	11.088	10.556	8.661	0.000	0.000	0.000	0.000	0.000	0.000	19.217	36.922	s
		Dept.	0.000	1.150	1.210	1.210	1.210	0.000	0.000	0.000	0.000	0.000	0.000	2.420	4.780	
		Total	**0.000**	**7.767**	**12.298**	**11.766**	**9.871**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**21.637**	**41.702**	
Innovation Access Programme - Information Technology Online	BAA	Admin.	1.988	2.020	1.598	1.920	2.270	1.130	0.000	0.000	0.000	0.000	1.130	5.320	10.926	s
		Dept.	0.464	0.465	0.424	0.381	0.340	0.000	0.000	0.000	0.000	0.000	0.000	0.721	2.074	
		Total	**2.452**	**2.485**	**2.022**	**2.301**	**2.610**	**1.130**	**0.000**	**0.000**	**0.000**	**0.000**	**1.130**	**6.041**	**13.000**	
Biotechnology Innovation Fund	BAA	Admin.	4.048	4.952	6.893	1.700	0.300	0.000	0.000	0.000	0.000	0.000	0.000	2.000	17.893	w
		Dept.	0.500	0.500	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.000	
		Total	**4.548**	**5.452**	**7.893**	**1.700**	**0.300**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**2.000**	**19.893**	
Commercial Ready Programme	BAA-BOFTSI	Admin.	0.000	0.000	0.000	1.176	7.960	190.912	208.930	222.371	225.957	200.838	1,049.008	1,058.144	1,058.144	k
		Dept.	0.000	0.000	0.000	3.700	4.622	20.088	20.472	20.016	20.949	20.604	102.129	110.451	110.451	
		Total	**0.000**	**0.000**	**0.000**	**4.876**	**12.582**	**211.000**	**229.402**	**242.387**	**246.906**	**221.442**	**1,151.137**	**1,168.595**	**1,168.595**	
Industry Cooperative Innovation Programme	BAA-BOFTSI	Admin.	0.000	0.000	0.000	0.000	0.100	4.713	5.720	5.850	4.210	1.300	21.793	21.893	21.893	
		Dept.	0.000	0.000	0.000	0.124	0.518	0.524	0.536	0.763	0.384	0.258	2.465	3.107	3.107	
		Total	**0.000**	**0.000**	**0.000**	**0.124**	**0.618**	**5.237**	**6.256**	**6.613**	**4.594**	**1.558**	**24.258**	**25.000**	**25.000**	
Commercialising Emerging Technologies (COMET) Programme	BAA + BAA-BOFTSI	Admin.	7.650	7.629	8.627	9.094	8.400	10.300	14.000	13.300	12.800	7.600	58.000	75.494	99.400	
		Dept.	2.350	2.350	2.350	4.250	4.900	5.100	4.800	5.400	5.100	4.000	24.400	33.550	40.600	
		Total	**10.000**	**9.979**	**10.977**	**13.344**	**13.300**	**15.400**	**18.800**	**18.700**	**17.900**	**11.600**	**82.400**	**109.044**	**140.000**	
Biotechnology World Class Centre of Excellence/Extend Support for National Stem Cell Centre	BAA + BAA-BOFTSI	Admin.	0.750	3.550	4.600	5.800	7.100	6.500	6.000	5.500	5.000	4.500	27.500	40.400	49.300	l
		Dept.	0.500	0.500	0.400	0.400	0.400	0.500	0.500	0.700	0.500	0.700	2.900	3.700	5.100	
		Total	**1.250**	**4.050**	**5.000**	**6.200**	**7.500**	**7.000**	**6.500**	**6.200**	**5.500**	**5.200**	**30.400**	**44.100**	**54.400**	
Refocussing the Cooperative Research Centres (CRC) Programme	BAA + BAA-BOFTSI	Admin.	0.000	0.000	53.980	55.980	62.820	44.900	64.000	31.000	43.000	-5.000	177.900	296.700	350.680	o
		Dept.	0.000	0.000	1.020	1.020	1.180	0.000	0.307	0.307	0.000	0.000	0.614	2.814	3.834	
		Total	**0.000**	**0.000**	**55.000**	**57.000**	**64.000**	**44.900**	**64.307**	**31.307**	**43.000**	**-5.000**	**178.514**	**299.514**	**354.514**	
Pre-Seed Fund	BAA	Admin. Capital	0.000	4.184	6.398	6.729	13.351	12.000	12.473	7.875	6.700	3.000	42.048	62.128	72.710	m,n
		Dept.	0.950	0.560	0.560	0.560	0.560	0.560	0.560	0.560	0.560	0.560	2.800	3.920	5.990	
		Total	**0.950**	**4.744**	**6.958**	**7.289**	**13.911**	**12.560**	**13.033**	**8.435**	**7.260**	**3.560**	**44.848**	**66.048**	**78.700**	
Extension of the Building on IT Strengths (BITS) Incubator Programme	BAA	Admin.	0.000	0.000	0.000	12.567	10.553	7.539	3.471	0.000	0.000	0.000	11.010	34.130	34.130	f
		Dept.	0.000	0.000	0.000	0.433	0.447	0.461	0.529	0.000	0.000	0.000	0.990	1.870	1.870	
		Total	**0.000**	**0.000**	**0.000**	**13.000**	**11.000**	**8.000**	**4.000**	**0.000**	**0.000**	**0.000**	**12.000**	**36.000**	**36.000**	
New Industries Development Programme (NIDP) Mark III	BAA	Admin.	2.886	3.030	2.247	3.545	2.640	2.288	2.480	2.580	2.680	1.290	11.318	17.503	25.666	
		Dept.	0.940	0.940	0.940	0.940	0.629	0.520	0.520	0.520	0.520	0.310	2.390	3.959	6.779	
		Total	**3.826**	**3.970**	**3.187**	**4.485**	**3.269**	**2.808**	**3.000**	**3.100**	**3.200**	**1.600**	**13.708**	**21.462**	**32.445**	

Backing Australia's Ability (BAA) 10 Year Funding Table - Current Expenditures and Forward Estimates as at May 2006 (a) (b) (c)

PROGRAMME			2001-02 ($m) Actual	2002-03 ($m) Actual	2003-04 ($m) Actual	2004-05 ($m) Actual	2005-06 ($m) Estimated Actual	2006-07 ($m) Budget Estimate	2007-08 ($m) Forward Estimate	2008-09 ($m) Forward Estimate	2009-10 ($m) Forward Estimate	2010-11 ($m) Forward Estimate	BAA-II 5 Year Total ($m)	BAAI + BAAII 7 Year Total ($m)	10 Year Total ($m)	Notes
SKILLS DEVELOPMENT																
Questacon Smart Moves - Raising Science Awareness in Schools and the Broader Community	BAA	Admin.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	t
		Dept.	0.700	1.200	1.200	1.557	1.661	1.657	1.772	1.772	1.772	1.772	8.745	11.963	15.063	
		Total	**0.700**	**1.200**	**1.200**	**1.557**	**1.661**	**1.657**	**1.772**	**1.772**	**1.772**	**1.772**	**8.745**	**11.963**	**15.063**	
National Innovation Awareness Strategy/Science Connections Programme	BAA	Admin. (DITR)	0.000	0.540	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.040	t
		Dept. (DITR)	1.804	2.100	2.050	2.896	4.090	0.000	0.000	0.000	0.000	0.000	0.000	6.986	12.940	
		Sub-total	**1.804**	**2.640**	**2.550**	**2.896**	**4.090**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**6.986**	**13.980**	
	BAA + BAA-BOFTSI	Admin. (DEST)	0.000	0.000	0.000	0.250	0.593	4.024	4.127	4.217	4.370	4.482	21.220	22.063	22.063	t
		Dept. (DEST)	2.500	3.160	3.250	3.504	4.910	0.749	0.766	0.783	0.801	0.819	3.918	12.332	21.242	
		Sub-total	**2.500**	**3.160**	**3.250**	**3.754**	**5.503**	**4.773**	**4.893**	**5.000**	**5.171**	**5.301**	**25.138**	**34.395**	**43.305**	
		Total	**4.304**	**5.800**	**5.800**	**6.650**	**9.593**	**4.773**	**4.893**	**5.000**	**5.171**	**5.301**	**25.138**	**41.381**	**57.285**	
Fostering Scientific, Mathematical and Technological Skills and Innovation in Government Schools	BAA	Admin.	33.100	34.900	36.800	107.051	134.170	145.758	143.649	135.974	125.016	110.061	660.458	901.679	1,006.479	p
		Dept.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
		Total	**33.100**	**34.900**	**36.800**	**107.051**	**134.170**	**145.758**	**143.649**	**135.974**	**125.016**	**110.061**	**660.458**	**901.679**	**1,006.479**	
2000 University Places	BAA	Admin.	13.900	24.700	33.000	39.500	40.300	41.100	41.800	42.600	43.400	44.300	213.200	293.000	364.600	r
		Dept.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
		Total	**13.900**	**24.700**	**33.000**	**39.500**	**40.300**	**41.100**	**41.800**	**42.600**	**43.400**	**44.300**	**213.200**	**293.000**	**364.600**	
Boosting Innovation, Science, Technology and Mathematics Teaching	BAA-BOFTSI	Admin.	0.000	0.000	0.000	5.813	10.221	5.118	5.186	3.995	2.845	2.079	19.223	35.257	35.257	
		Dept.	0.000	0.000	0.000	0.500	0.600	0.500	0.600	0.514	0.408	0.416	2.438	3.538	3.538	
		Total	**0.000**	**0.000**	**0.000**	**6.313**	**10.821**	**5.618**	**5.786**	**4.509**	**3.253**	**2.495**	**21.661**	**38.795**	**38.795**	
Extend and Enhance National Biotechnology Strategy and Biotechnology Australia	BAA-BOFTSI	Admin.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	f
		Dept.	0.000	0.000	0.000	5.000	5.000	5.000	5.000	0.000	0.000	0.000	10.000	20.000	20.000	
		Total	**0.000**	**0.000**	**0.000**	**5.000**	**5.000**	**5.000**	**5.000**	**0.000**	**0.000**	**0.000**	**10.000**	**20.000**	**20.000**	
Online Curriculum Content for Schools	BAA	Admin.	3.751	6.453	6.614	6.700	7.113	0.000	0.000	0.000	0.000	0.000	0.000	13.813	30.631	
		Dept.	0.749	0.747	0.787	0.800	0.817	0.000	0.000	0.000	0.000	0.000	0.000	1.617	3.900	
		Total	**4.500**	**7.200**	**7.401**	**7.500**	**7.930**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**15.430**	**34.531**	
Post Graduate Education Loans Scheme (PELS)	BAA	Admin.	0.000	-2.400	-8.100	-12.100	-16.300	0.000	0.000	0.000	0.000	0.000	0.000	-28.400	-38.900	q
		Dept.	0.700	0.400	0.400	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.800	2.300	
		Total	**0.700**	**-2.000**	**-7.700**	**-11.700**	**-15.900**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**-27.600**	**-36.600**	
Attracting ICT Workers	BAA	Revenue	-0.779	-1.006	-1.041	-1.077	-1.102	0.000	0.000	0.000	0.000	0.000	0.000	-2.179	-5.005	
		Dept.	0.279	0.291	0.303	0.316	0.316	0.000	0.000	0.000	0.000	0.000	0.000	0.632	1.505	
		Total	**-0.500**	**-0.715**	**-0.738**	**-0.761**	**-0.786**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**-1.547**	**-3.500**	
		GRAND TOTAL	**169.522**	**319.879**	**598.206**	**862.041**	**1,085.860**	**1,228.585**	**1,281.914**	**1,205.165**	**1,226.568**	**1,144.844**	**6,087.076**	**8,034.977**	**9,122.584**	a,v
		ANNOUNCED TOTALS (BAA II press kit)	**170.800**	**395.500**	**617.700**	**899.377**	**1,076.596**	**1,003.721**	**1,047.560**	**1,027.630**	**1,064.543**	**1,028.251**	**5,171.705**	**7,147.678**	**8,331.800**	b

NOTES

(a) This table differs from the budget table in the media release in that it reflects current expenditures. The 10 year total of the media release for BAA-BOFTSI only includes new measures and reprioritisation of existing funding that have an impact on the fiscal balance. Expenditures from existing BAA programs that have already been factored into the forward estimates were excluded in the media release table. This explains the disparity between the total current expenditure and the announced totals.

(b) Total budgeted expenditures announced in the original 10 year table are included for comparison.

(c) Where possible, programs from the initial five year package that have been merged or refocussed in the second seven year package are presented separately.

(d) The National Competitive Grants program received additional funding of $275m in the 2003-04 Budget for 2006-07 to enable efficient operation of multi-year grants. A total of $7.2m from the program has been transferred to the Department of Prime Minister and Cabinet to fund targetted counter terrorism research (this measure is included in the table).

(e) $2.31m from the 2005-06 SII appropriation was reallocated to fund the National Centre for Language Training. SII and MNRF will be replaced by the National Collaborative Research Infrastructure Strategy in 2006-07. Funding was provided in 2004-05 and 2005-06 to establish the new initiative.

(f) Continues an existing program not previously included under BAA.

(g) The ICT Centre of Excellence also receives funding from the National Competitive Grants Program administered by the Australian Research Council (ARC). For the period 2001-02 to 2005-06, the ICT Centre of Excellence received a total of $131.3m and $251.1m for 2006-07 to 2010-11.

(h) Assumes ongoing funding/revenue foregone (net revenue) for these initiatives at 2005-06 levels. For the premium tax concession, the tax offset and the streamlining of the 125% tax concession programs, Sections 73b-y of the Income Tax Assessment Act provide the basis for the assumption.

(i) The amounts for the 125% R&D tax concession refers to the savings due to a change to effective life treatment of R&D plant introduced in BAA. For the 2004-05 to 2007-08 financial years, the refundable R&D Tax Offset is treated as an expense item in the Tax Expenditure Statements (TES) and accordingly does not appear as a tax expenditure in its own right. Payments made under the Offset are exempt from tax and the figures that are included in the TES is the tax revenue forgone on the Offset payment (accrued because the Offset is a non-taxed payment to firms). The TES figures, thus, reflect only part of the total cost of the Offset. The actual cost to revenue of the Offset itself is recorded as an Administered expense in the ATO Portfolio Budget Statement. This cost is not, however, recorded as a separate line item in the ATO statement. Hence, the component of the cost to revenue cannot be identified.

(j) Does not include administered capital which is provided in the form of loan funding. DITR's most recent estimates for the loan component stand at $8m in 2002-03, $10m in 2003-04, $9.5m in 2004-05 and $9m in 2005-06. A sum of $7.9m was transferred from the 2005/06 R&D Start budget to fund the Food Innovation Grants Strategy administered by AFFA. R&D Start has been subsumed into the Commercial Ready Program from 2006-07.

(k) This includes the allocation of additional funding of $41m for the R&D Start program in 2006-07 announced in the 2003-04 Budget .

(l) The National Stem Cell Centre also receives funding from the National Competitive Grants Program administered by the Australian Research Council (ARC). Only the funding for the BAA program component is detailed here.

(m) Includes administered capital component as original funding was allocated in the form of a grant but has subsequently been reclassified as a loan.

(n) In August 2001, reflecting the change from a grant to a loan program, the initial $78.7m for the Preseed Fund Initiative for the five year BAA period was reprofiled to run over a 10 year period through to 2010-11.

(o) This includes additional funding of $62.5m in the 2003-04 Budget for 2006-07 to enable efficient operation of multi-year grants.

(p) The Enrolment Benchmark Adjustment (EBA) is based on the funding arrangement between the Australian Government and States. The EBA accounts for the shift in enrolments from government to non-government school resulting in savings to the States. This measure is budget neutral as the EBA liability that would otherwise be returned to the Australian Government is retained by States for the express purpose of building science and innovation capacity in schools. The out-years have already been included in the forward estimates and hence, have not been included in the announced figures in the media release (see also 2004-05 Budget Paper No. 2, Part 2 Expense Measures p. 137). It has been included here to indicate the impact of continuing Government commitments under this initiative.

(q) In the 2003-04 Budget, PELS was subsumed by a new loan facility FEE-HELP. The net revenue amounts (calculated by estimating the value of loans less the value of repayments adjusted for inflation) shown in this table represent DEST's most recent and final estimates for the PELS program as at 2003-04 Budget. Due to the abolition of the PELS program as it stands in isolation, these estimates will not be adjusted in future and so will become unreliable post May Budget 2003. These figures are based on 2001-02 revised estimates.

(r) The amounts indicated are as announced in the 2002-02 and 2004-05 Budgets. The actual amount received by providers depends upon the Higher Education Indexation Factor that applies in the year it is paid.

(s) In the original 5 year package, the Innovation Access Program (IAP) consisted of: IAP-International Science & Technology (DEST), IAP-Industry (DITR) and Information Technology Online (DCITA).

(t) The Science Connections program will replace the National Innovation Awareness Strategy initiative.

(u) The Minister authorised the transfer of $3.3 million from the 2004-05 appropriation for the Systemic Infrastructure Initiative to the Innovation Program.

(v) The main contributing factors to the disparity between the actuals and announced figures for 2002-03 is the downward revision of the Systemic Infrastructure Initiative due to revised reporting to reflect expenditure in financial year terms, a reduction in the 175% Premium R&D Tax Concession claims, and a reduction in the R&D Start. For 2003-04, the variation is due to a reduction in the 175% Premium R&D Tax Concession claims and R&D Start expenditure due to rephasing (see also DITR 2004-05 PBS, Part C: Agency Budget Statements p. 34). The reductions have been partially off-set by the increase in expenditure for the Systemic Infrastructure Initiative due to the reporting of expenditure in financial-year terms. The increase in the 10 year total budget for BAA and BAA-BOFTSI is due almost entirely to the inclusion of the forward estimates for the Fostering Scientific, Mathematical, Technological Skills and Innovation in Government Schools, which, as indicated in note (p), is to provide an indication of the impact of the Government's continued commitments under this initiative.

(w) The Biotechnology Innovation Fund has been subsumed into the Commercial Ready Program from 2006-07.

Source: Department of Education, Science and Training.

Attachment B- Exogenous shocks associated with the removal of the CRC program.

Exogenous shocks associated with the removal of the CRC program ($m deviation from basecase values, current prices)

Shock	Industry	92	93	94	95	96	97	98	99	2000	2001	2002	2003	2004	2005	Anually 2006 to 2010
Net cost changes	coal mining	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 12.3	-$ 12.3	-$ 4.3	$ 8.0	$ 8.0	$ 8.0
Net cost changes	gas pipeline	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 20.0	$ 20.0	$ 20.0	$ 20.0	$ 20.0	$ 20.0
Net cost saving	naval ship building	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 120.0	$ -	$ -
Net cost changes	food and beverage manufacturing	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.7	$ 4.7	$ 4.7	$ -
Net cost changes	metals manufacturing	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.6	$ 6.6	$ 6.6
Net cost changes	minerals extraction	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 22.3	$119.6	$ 20.6	$ 20.6	$ 20.6
Net cost changes	minerals extraction	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.6	$ 0.6	$ 0.6
Net output change	minerals extraction	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 6.2	-$ 6.2	-$ 6.2	-$ 6.2
Net output change	minerals extraction	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 6.7	-$ 6.7	-$ 6.7
Gross output change	defence ship building sector	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 2.0	-$ 2.0	-$ 2.0	$ -	$ -
Gross output change	telecommunications equipment sector	$ -	$ -	$ -	$ -	-$ 0.7	-$ 1.4	-$ 8.9	-$ 8.4	-$ 49.7	-$ 29.2	-$ 26.8	-$ 23.4	-$ 16.9	-$ 13.0	$ -
Gross output change	cattle medicine sector	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 1.0	-$ 1.0	-$ 1.0	-$ 1.0	-$ 2.0	$ -
Gross output change	IT software sector	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 1.0	-$ 1.0	-$ 13.5	$ -
Gross output change	financial services sector	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 1.2	$ -
Gross output change	polimer insulating cables sectos	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 8.3	-$ 8.3	$ -
Gross output change	plastics manufacture sector	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 0.7	-$ 1.0	-$ 2.0	$ -
Net change in foreign IP revenue	medical research sector	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 26.0	$ -	$ -	$ -	$ -	$ -	$ -
Net change in foreign IP revenue	telecommunication research	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 6.0	$ -	$ -	$ -	$ -	$ -	$ -
Net cost changes	water treatment sector	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 26.0	$ 26.0	$ 26.0
Net change in foreign IP licensing incoming	health products	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 2.2	-$ 2.2	-$ 2.2	-$ 2.2	-$ 2.2	-$ 2.2	$ -	$ -
Net change in costs	government health (drugs)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 6.0	$ 6.0
Net change in output	fishery sector	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 3.2	$ -	$ -
Gross output change	scientific equipment sector	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 0.2	-$ 0.3	-$ 0.3	$ -
Net change in foreign IP revenue	pharmaceuticals research	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-$ 0.1	-$ 0.2	-$ 0.3	$ -
Gross output change	construction	$ -	$ -	$ -	$ -	$ -	$ -	-$ 0.4	-$ 0.7	-$ 0.7	-$ 0.2	-$ 0.2	-$ 0.2	-$ 0.3	$ -	$ -

Source: The Allen Consulting Group (2005), "The Economic Impact of CRC in Australia"

Attachment C- A Guide to Econtech's Murphy Model 600 Plus (MM600+)

This Appendix provides a guide to Murphy Model 600 Plus (MM600+).

Type of Model

MM600+ can be compared with MM2, Econtech's economic forecasting model. Econtech first forecasting model was MM, developed in 1987/88, followed by two versions of MM2, the first in 1994 and the second in 1996. These models are based on quarterly data. Comprehensive dynamic structures are used in generating quarter-by-quarter forecasts of the economy extending nine years into the future. Econtech distributes MM2 in MM Simulator for Windows software, which is widely used by businesses and governments to produce their own forecasts and scenarios for the Australian economy.

Econtech's first industry model, MM303, was developed in 1997/98. It was then upgraded to MM600+ in 1999/00 under a contract to the Australian Competition and Consumer Commission. These models are based on a very detailed picture of the industrial structure of the economy that can only be found in the input-output tables published by the ABS. MM600+ uses the unpublished version of these tables to distinguish the production of 672 products by 108 industries. MM600+ is currently implemented in Excel and is used by Econtech in project consulting engagements for businesses and governments.

In developing two different types of economic models for forecasting and industry work, Econtech has followed a "horses for courses" approach. The forecasting model, MM2, provides quarter-by-quarter results but only distinguishes 18 industries. The industry model, MM600+, distinguishes 672 products, but only provides short-term and long-term results. It is not practicable to integrate both models into a single "super" model that provides quarter-by-quarter results for 672 products because quarterly ABS data are not available at that fine level of product detail.

MM600+ can be compared with other industry models such as the PRISMOD model of the Department of the Treasury and the Monash Model of the Centre of Policy Studies at Monash University in three key areas:

- detail;
- coverage; and
- time dimension.

MM600+ has a high level of detail in terms of both products and indirect taxes.

In MM600+, 108 industries produce 672 products. The other two models distinguish about 110 products.

MM600+ distinguishes 24 types of existing indirect taxes plus a GST of any design. This is similar to PRISMOD, while Monash has less tax detail with three types of existing indirect taxes and no GST.

Turning to economic coverage, MM600+, like Monash, is a computable general equilibrium (CGE) model, giving it wide coverage of the Australian economy. While PRISMOD covers only industry costs and prices, MM600+ and Monash also cover industry production and employment.

The third and final area of model comparison is the time dimension. As explained in sections 6 and 7, MM600+ provides estimates of both short-term and long-term effects. By comparison, PRISMOD provides estimates of long-term effects only. While Monash does not provide estimates of long-term effects, it does provide estimates of year-by-year effects.

Table A.1
Model Comparison

Model	MM600+	PRISMOD	Monash
Products	672	107	about 110
Indirect taxes	25	similar	3
Coverage	prices, production	prices	prices, production
Time dimension	short & long term	long-term	annual

CGE modelling is well-established in Australia due mainly to the pioneering work of Peter Dixon in developing the ORANI model and then the Monash Model.

While some Australian CGE models are adaptations of Dixon's ORANI model, MM303/MM600+ was developed from scratch. At the same time, there are similarities between the models.

This is partly because ORANI and MM600+ are both in the CGE family, and therefore model computable, market-clearing outcomes under optimising behaviour. Similarly they both inevitably rely on input-output tables published by the ABS.

It is also because Dixon's work, as reported in Dixon, Parmenter, Sutton and Vincent (1982) and Dixon, Parmenter, Powell and Wilcoxen (1992), was an important source of ideas for MM600+ such as:

- import demand for each commodity is modelled in three categories: intermediate goods, consumption goods, and investment goods; and
- there is a detailed treatment of distribution margins.

The ORANI model also has some ideas not found in MM600+, including some refinements specific to agriculture. Equally, MM600+ has some ideas not found in ORANI/Monash, including an extended range of economic choices or behavioural responses, as discussed in section 5.

Beyond these similarities and differences in ideas, the main differences between the two models are in the areas of detail and time dimension, as already summarised in Table A.1.

Implementation of Model

Implementing MM600+ involved constructing a database, choosing a software environment, setting up a baseline simulation, and then putting the model into action performing simulations of actual or proposed economic shocks.

Econtech obtained a special series of the input-output tables from the ABS. In these unpublished tables, 107 industries produce about 1,000 products, compared with the published tables which only distinguish 107 products i.e. one product per industry. The unpublished tables also include a series of special tables containing extra detail on indirect taxes.

In constructing the database for MM600+, the ABS input-output data were manipulated to give an exactly-balanced, economically meaningful database. This included the following adjustments:

- aggregating from about 1,000 products to 672 products;
- treating "Sales by Final Buyers" as sales of used cars;
- constructing a travel composite commodity, used in modelling export demand for inbound travel in Australia;
- identifying household and business import demand for Australian travel overseas.
- balancing industry usage with product supply;
- imputing labour income to employers and self-employed; and
- allocating inventory investment.

Turning to the topic of software environment, MM600+ is implemented in Excel. The database is constructed in a series of workbooks linked backed to raw ABS data, which is also in the form of Excel workbooks. This implementation gives easy access to all model inputs, outputs and equations. Thus all inputs and equations can be altered and all outputs can be viewed.

MM600+ is specified in levels as a non-linear system, not in changes as a linear system, so model solutions are always exact. It is solved iteratively in Excel using Excel's standard iterative method for resolving "circular references". A model simulation in Excel under a very tight convergence criterion[26] takes about 30 minutes and involves about 500 iterations of the model.

Simulations of economic shocks involve varying the values of one or more model inputs relative to their baseline values. With open access to all model inputs, a wide variety of shocks can be conducted. These can involve virtually any shift in technology, tastes, foreign demand or taxation.

To enable more sophisticated analysis of the welfare effects of taxation and other reforms, the model provides for positive/negative externalities in consumption for each product, the values for which can be set by the model user.

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[26] For example, for convergence, annual GDP, which is about $500,000,000,000, can change by no more than $1,000 from the previous iteration, implying a precision of 1 in 500,000,000.

Product Detail

As noted in the previous section, in the input-output tables published by the ABS, 107 industries produce 107 products.

In building MM600+, Econtech decided to incorporate a higher level of product detail than found in the published input-output tables. This is available in unpublished input-output tables that we obtained in electronic form from the ABS. The ABS derives the published tables by aggregating from these more detailed unpublished tables.

While the unpublished tables include about 1,000 detailed products, some aggregation was necessary because some data for detailed products are censored by the ABS to protect the confidentiality of individual companies. However, aggregation was kept to a minimum. This gave the 672 products that appear in MM600+ .This is the maximum achievable level of product detail.

The high level of product detail in MM600+ has many advantages. In commissioning MM600+ as a further development of Econtech’s earlier CGE model, MM303, the ACCC requested the high level of product detail so that model estimates could serve as a more useful point of comparison in the ACCC's price monitoring work.

The high level of product detail also means that many policy changes can be analysed without the need for further disaggregation. For example, petrol and diesel are distinguished from other petroleum products, making it easier to accurately model the changes in fuel taxation under the New Tax System, as these tax changes are different for petrol, diesel and other fuels.

It also means that the gains from some micro-economic reforms can be more fully captured. For example, a finer level of disaggregation better reveals the diversity in rates of customs duty, leading to more reliable estimates of the gains from tariff reforms that produce benefits by reducing this diversity.

Tax Detail

The treatment of taxation is particularly detailed in MM600+. The model distinguishes 24 different indirect taxes on industry production and products, as listed below. These can each be varied either universally, or as they apply to each industry or product or end purchaser. In addition, MM600+ provides for a GST, under which each product/industry can be classified as taxable, input-taxed or GST-free.

Production Taxes	Product Taxes
Land Tax	GST
LGA Rates	Sales tax
Liquor & Gambling Taxes	Stamp Duty
Payroll Tax	Gambling Taxes; Former State Licence Fees
Taxes on Insurance	Primary Production Taxes
Motor Vehicle Taxes	Regulatory Service Fees
Stamp Duties	Excise Taxes
Taxes on use of goods etc	Motor Vehicle Taxes
Fringe Benefits Taxes	Financial Institution Duties

Departure Tax	Customs Duty on Exports
Other Indirect Taxes nec	Other Commodity Taxes
Total Subsidies	Commodity subsidies
	Customs Duty on Imports

This high level of indirect tax detail is only possible because MM600+ uses the unpublished input-output tables. While these unpublished tables distinguish 24 categories of indirect taxes, the published tables distinguish only three categories.

In modelling the changeover to the New Tax System, it was important to accurately represent the application to industries and products of sales tax, GST and fuel taxes.

The ABS input-output tables have significant shortcomings in their application of sales tax to products. For example, they do not allow for the "aids to manufacture" exemption on sales tax on inputs into the agriculture, mining, manufacturing and utilities industries. They also overstate sales tax collections on motor vehicles.

Also, obviously the input-output tables do not incorporate the just-introduced GST.

To address these sales tax and GST areas, Econtech commissioned a review by KPMG of the wholesale sales tax and GST treatments of each of the 672 products appearing in the model. We also built in the "aids to manufacture" exemption form sales tax. These tax assumptions were in turn reviewed by the ACCC in conjunction with the ATO.

The remaining significant complication in accurately modeling the changeover to the New Tax System is the complex nature of the changes to fuel taxation. MM600+ takes into account that changes in diesel fuel tax are different in each on the following areas:

- qualifying road use;
- non-qualifying road use;
- rail and marine transport;
- agriculture and fishing use;
- mining use; and
- other non-transport use.

MM600+ also takes into account that *ANTS* does not include any cuts to taxation of fuel used in air transport, including both aviation turbine fuel and aviation gasoline.

Economic Choices and Elasticities

MM600+ models how changes in relative prices affect economic choices, leading to changes in the industry pattern of production and employment. The main price-sensitive choices in the model involve:

- business choice between labour and capital;
- business choice between different types of capital;
- business choice between different forms of energy;

- business choice between road and rail freight transport;
- business choice of its size;
- choice between import and local sources of supply;
- business choice between local and export destinations for sales;
- consumer choice between broad commodity groups;
- consumer choice within broad commodity groups; and
- demand for Australian exports.

In modelling economic choices, values need to be assigned to the elasticities that govern the sensitivity of each choice to changes in relative prices. The following explains each of the economic choices listed above in more detail and also gives the associated values for the elasticities. The only elasticities not presented below are trade elasticities.

Substitution between labour and capital

The elasticity of substitution between labour and capital in production in each of the 108 industries is set to 0.75 in MM600+, consistent with Econtech's econometric research for MM2.

Substitution between different types of capital inputs

MM600+ provides for substitution between different types of business capital e.g. motor vehicles, computers, buildings etc. Business holdings of motor vehicles and computers are price sensitive, making it important to allow for substitution between different forms of business capital.

In MM600+ the elasticity of substitution between different forms of business capital is set at 0.5. In modelling this substitution, the user cost of each form of capital is calculated by applying a required rate of return plus a depreciation rate to the price of new investment, where both the depreciation rate and the price of new investment vary from one form of capital to the next.

Substitution between different forms of energy

MM600+ allows for substitution by business between different forms of primary energy, including black coal, brown coal, LPG and natural gas. Allowing for these substitution possibilities is vital when assessing the economic effects of energy development projects, or in examining greenhouse gas emission issues.

For most industries, the elasticity of substitution between forms of primary energy is set to 4.5. The exception is the electricity industry, where the elasticity has been set to 6, to reflect the high sensitivity of the choice of type of electricity generation to the relative cost of different forms of energy.

Substitution between road and rail freight transport

MM600+ allows for substitution by industry between road and rail freight transport. It does this by drawing on earlier work by the Industry Commission, incorporated in the ORANI-HILMER model, on the elasticity of substitution between road and rail freight transport. For most products this elasticity is set to 2, but lower values are used for some products. Substitution between freight transport modes is modelled both for transport from business to business (or importer to business) and from business to export wharves.

Business choice of its size

In MM600+, the representative business in each industry selects its size to minimise unit costs. The small business exemption from payroll tax distorts this choice so that in each industry the selected size is less than the technically efficient size.

In modelling the technically efficient size, it is assumed that for the representative business in each industry the need for primary factors (i.e. capital and labour), F, depends on its level of output, Q, according to the following equation.

$$F = Q + a.(QC - Q) + a.Q.\ln(Q/QC)$$

For technical efficiency, Q=QC. The sensitivity of efficiency to variations in Q away from QC is given by the parameter a. Fuss and Gupta, analysed 91 Canadian manufacturing industries and found that there was an average loss of efficiency of about 4 per cent from operating at one-half of the technically efficient scale. Using that result, in MM600+ the parameter a has been set to equal 0.13 in each industry.

In most states, payroll tax is calculated by applying the payroll tax rate to the business wage bill net of a tax-free threshold. This threshold provides a larger reduction in unit cost for smaller businesses than for larger businesses, distorting the choice of business size.

The technically efficient business size, QC, was then set separately for each industry so that the model correctly predicts industry payroll tax collections. This involves using the corollary of the fact that industries dominated by small businesses do not pay much payroll tax because of the tax-free threshold.

The model has been used to examine the distorting effect of the small business exemption from payroll tax on business size in an Econtech report of 23 June 1998 for the Australian Chamber of Commerce & Industry on “Payroll Tax: Is it as Good as a VAT or as bad as sales tax?”.

Substitution between imports and local supply

As in the Monash Model, allowance is made for substitution between imported and local sources of supply for each importable commodity for each of three categories of end use. The categories of end use are: recurrent inputs; business investment; and other components of final demand. The values of the Armington elasticities governing this substitution were originally based on those used in the Monash Model in 1997, but some have been modified in the light of experience with MM600+.

Substitution of local producers between supplying the export and home markets

In modelling export supply, MM600+ distinguishes between the production of a commodity for the home market and production for the export market. For each commodity, an elasticity of transformation links production for the two markets.

To the extent that a commodity's transformation elasticity is set to less than infinity (the value implicit in the ORANI model), an allowance if made for some friction in switching supply between the two markets. This friction may arise because some exported commodities are tailor made for export, or are more narrowly defined than the corresponding home commodity e.g. Australian consumers may eat all types of apples while we may only export Fuji apples to Japan — this affects the ability to switch supply between the two markets.

Based on model simulation experiments, the exports elasticity of transformation has been set to 0.5 for water transport and black coal, 1.5 for other minerals, and 2.5 for all other exports.

Substitution between broad consumption groups

Substitution between broad consumption groups is modelled in a linear expenditure system of consumer demand. The parameters of this system were estimated by Econtech using quarterly national accounts data extending from 1974-75 to 1996-97 and are set out in Table A.2. Implied price and income elasticities are also presented in Table A.2.

As expected, consumer demand for the following groups is income inelastic: food; cigarettes & tobacco; gas, electricity & fuel; fares; and operation of motor vehicles. Equally, consumer demand for the following groups is income elastic: financial services; other services; and personal travel imports (i.e. overseas holidays);

Table A.2
Consumption Group Parameters and Elasticities
Estimation Period: 1974.3-1997.2

		β	γ	Budget share	Income elast.	Price elas.	ν
A	Food	0.078	1320	14.5%	0.54	-0.34	-1.0
B	Cigarettes and tobacco	0.011	164	1.9%	0.57	-0.39	-0.5
C	Alcoholic drinks	0.040	187	4.1%	0.97	-0.65	-1.0
D	Clothing, fabrics and footwear	0.041	342	5.2%	0.78	-0.52	-0.5
E	Household appliances	0.031	93	2.9%	1.10	-0.73	-0.5
F	Other household durables	0.032	233	3.8%	0.83	-0.55	-0.5
G	Health	0.084	268	7.8%	1.08	-0.68	-0.5
H	Dwelling rent	0.208	531	18.4%	1.13	-0.62	-0.5
I	Gas, electricity and fuel	0.012	205	2.2%	0.52	-0.36	-1.0
J	Fares	0.010	160	1.8%	0.54	-0.37	-1.0
K	Purchase of motor vehicles	0.042	119	3.8%	1.11	-0.73	-0.5
L	Operation of motor vehicles	0.045	440	6.2%	0.72	-0.48	-0.1
M	Postal and telephone services	0.019	72	1.8%	1.03	-0.70	-0.5
N	Entertainment and recreation	0.038	314	4.9%	0.79	-0.52	-0.75
O	Financial services	0.054	1	3.9%	1.40	-0.92	-0.5
P	Other goods	0.093	67	7.1%	1.31	-0.82	-0.5
Q	Other services	0.130	-161	8.2%	1.59	-0.96	-0.5

R	Personal Travel Imports	0.032	-103	1.6%	2.03	-1.36	-0.5

Substitution within broad consumption groups

MM600+ also allows for substitution within broad consumption groups. Alcoholic drinks serves as an example. Clements et al. conclude that "the price elasticity of alcohol as a whole is about -1/2" (p.77). However, because of substitution between different forms of alcohol, price elasticities for individual alcoholic beverages are larger at –0.8, –0.7 and –1.9 for beer, wine and spirits respectively (p. 78). Thus it is important to allow not only for substitution between broad consumption groups, but also for substitution within consumption groups.

To allow for substitution within consumption groups, the consumer demand system in MM600+ is derived from a generalisation of the indirect utility function associated with the linear expenditure system. In this two-level generalisation, an intra-group substitution parameter, ν, appears which can take different values for different groups, as shown in the last column of Table A.2. This parameter is set to –0.5 for most groups (zero equates to no intra-group substitution, as in the Monash model). This value implies that the price elasticity for an individual consumption commodity is up to 1.5 times the size of the price elasticity for the consumption group in which it belongs.

Under this approach, consumer demand for consumption of commodity *k* in group *i* is given by the following equation.

$$X_{ik} = \alpha_{ik}.\gamma_i + \phi_{ik}.(\beta_i/P_{ik}).(C - \Sigma P_j.\gamma_j).(Q_i/P_{ik})^{-\nu i}$$

where:

$$P_i = \Sigma \alpha_{il}.P_{il} \text{ for all i}$$

$$Q_i = [\Sigma \phi i_l.P_{il}^{\nu i}]^{1/\nu i} \text{ for all i}$$

$$\Sigma \alpha_{il} = 1 \text{ for all i}$$

$$\Sigma \phi_{il} = 1 \text{ for all i}$$

$$\Sigma \beta_i = 1$$

Export demand

Export demand elasticities in MM600+ range from -4 for wool, where Australia has market power, and tourism, where product differentiation is important, to -12 for a broad range of exports. The pattern of elasticities for minerals and minerals processing were developed in 1998 in consultation with Malcolm Gray, a commodities consultant engaged by the Minerals Council of Australia.

Long-term Closure

MM600+ has two different closures frames — a short-term closure and a long-term closure — so that it can provide results from an economic shock for two different time frames. The long-term closure is described in this section while the short-term closure is described in the next section.

The long-term closure models a long-run equilibrium. For most economic shocks, the long run is likely to be attained in five to ten years.

In the long-run, economic agents optimise, all markets are in equilibrium, and assets and liabilities follow sustainable paths. Some of the key assumptions involved are:

- *profit maximisation*: the representative business in each industry chooses inputs and outputs to maximise profit subject to prices and a production function exhibiting constant returns to scale. This involves choosing inputs of capital and labour and outputs for the local and export markets;

- *labour market equilibrium*: in the long-run the labour market is assumed to attain equilibrium, so that an economic shock has no lasting effect on total employment. This assumption is implemented by fixing the level of total employment;

- *external balance*: in the long-run net liabilities to the foreign sector must follow a sustainable path. This assumption is implemented by setting the trade balance equal to the cost of servicing payments on foreign-owned capital — the real exchange rate needed to achieve this outcome is determined by the model;

- *budget balance*: in the long-run the budget balance must be sustainable. Specifically, in MM600+ the government budget is assumed to be in balance. It is necessary to designate a swing fiscal policy instrument to achieve that outcome. Generally, the rate of tax on labour income is used as the swing fiscal policy instrument; and

- *private saving*: in the long-run the level of private sector saving and associated asset accumulation must be sustainable. Further, one potential problem with long-run models is that saving (i.e. sacrificing present consumption for future consumption) can appear artificially attractive, because the model results show the gain in future consumption but not the sacrifice of present consumption. To address both of these issues, saving is held constant in MM600+ by fixing the quantity of capital that is owned locally.

MM600+ pays particular attention to the correct measurement of changes in national economic welfare. It uses the compensating variation and equivalent variation from welfare economics. These are alternative measures of the gain in real consumer spending.

More specifically, under a linear expenditure system model of consumer demand, these measures of welfare change virtually equate with changes in real supernumerary (or non-essential) consumption. Real supernumerary consumption is calculated by subtracting nominal "essential" consumption from nominal total consumption to obtain nominal supernumerary consumption, before deflating using the ideal price index for supernumerary consumption.

In MM600+ effects on vertical equity can also be measured. This is done by calculating movements in real supernumerary consumption for consumers at different income levels. In the results, the benefits of an economic reform are tilted towards low-income earners if the ideal price index for essential consumption falls by more than the ideal price index for supernumerary consumption.

Short-term Closure

The long-term closure factors in full adjustment of industry capital stocks to economic shocks, which is a protracted process that may take five to ten years.

Because of this lengthy capital stock adjustment process, short-term closures have been developed for economic models. These short-term closures hold industry capital stocks fixed.

In the case of MM600+, the short-term closure is different because it was developed under a contract to the ACCC to mimic the price exploitation guidelines issued by the ACCC in March 2000. Under these guidelines, businesses:

> "should not increase the net dollar margins on their goods and services as a result of the New Tax System changes alone".

While this rule applies to June 2002, the short-term closure is only designed for the introduction year of the New Tax System, 2000/01.

Under this short-term closure, the long-term closure is modified by holding fixed the price of capital services in each industry. This means that changes in the cost of non-capital inputs flow through fully into prices, but changes in the cost of capital inputs have no effect on prices.

This is a reasonable representation of the ACCC guidelines as they apply in 2000/01.

Under the guidelines, savings in the cost of capital inputs only need to be passed on into prices as existing capital is replaced. This would not occur to a significant extent in 2000/01, so it is reasonable to model the guidelines by holding fixed the cost of capital inputs.

Equally, the ACCC guidelines require that savings in the cost of non-capital inputs are passed on fully into prices, and this is also captured in the short-term closure.

The short-term closure is only designed to mimic the ACCC guidelines, not other short-term applications, where a more conventional short-term closure based on fixed capital stocks would need to be used.

A conventional short-term closure is similar in that changes in the cost of capital inputs would have no effect on prices. However, it differs in that only part of changes in the cost of non-capital inputs would flow through into prices, with the proportion varying from one product to the next depending on supply and demand elasticities in each market.

Applications

MM303/MM600+ has been used in modelling the changeover to the New Tax System as well as many other applications.

The changeover to the New Tax System has been modelled for:

- companies
- industry associations
- governments; and
- the ACCC.

Companies

MM303/MM600+ is the most widely used model for estimating the effects of the New Tax System on company costs. MM600+ services have been supplied to companies by Econtech itself as well as through Ernst & Young, KPMG and Firmstone & Feil. These taxation services have been used by major companies in each of the following industries.

- mining
- pharmaceuticals
- other manufacturing
- media
- water
- retailing
- hotels
- road transport
- rail transport
- communications
- banking
- insurance
- professional services

Industry Associations

Econtech has used MM303/MM600+ to analyse the effects of the New Tax System for the following industry associations.

- Australian Automobile Association
- Australian Chamber of Commerce & Industry
- Australian Bankers Association
- Australian Hotels Association
- Australian Pharmaceutical Manufacturers Association
- Distilled Spirits Industry Council of Australia
- Housing Industry Association
- Master Builders Australia
- Minerals Council of Australia
- Plastics and Chemicals Industry Association
- Printing Industry Association of Australia
- Water Services Association of Australia

Governments

Econtech developed the Econtech ANTS Savings Calculator, which has been used by the following governments for estimating the effects of the New Tax System on the costs of their agencies.

- Commonwealth Government
- New South Wales Government
- Victorian Government
- Queensland Government
- WA Government
- SA Government
- Tasmanian Government
- ACT Government
- NT Government

ACCC

- Under contract to the ACCC, Econtech further developed its MM303 model to produce MM600+.

- The ACCC has used the results from MM600+, together with industry information, in its Shopping Guide covering the likely effects of ANTS on about 200 consumer prices.

- The ACCC Small Business Cost Savings Estimator - a tool to help small business comply with the ACCC price exploitation guidelines - was developed for the ACCC by Econtech.

Other Applications

MM303/MM600+ was also used in the following industry policy consultancies.

- a study for Chevron of its proposed natural gas pipeline from PNG to Gladstone

- a study for a major corporation of a proposed shale oil project

- a study for an oil company of a possible business decision with major implications for the oil industry

- a study for the Australian Greenhouse Office on National Average Fuel Consumption

- a study for two oil companies of a proposed merger of their oil refining operations.

Attachment D- Additional Scenario 1

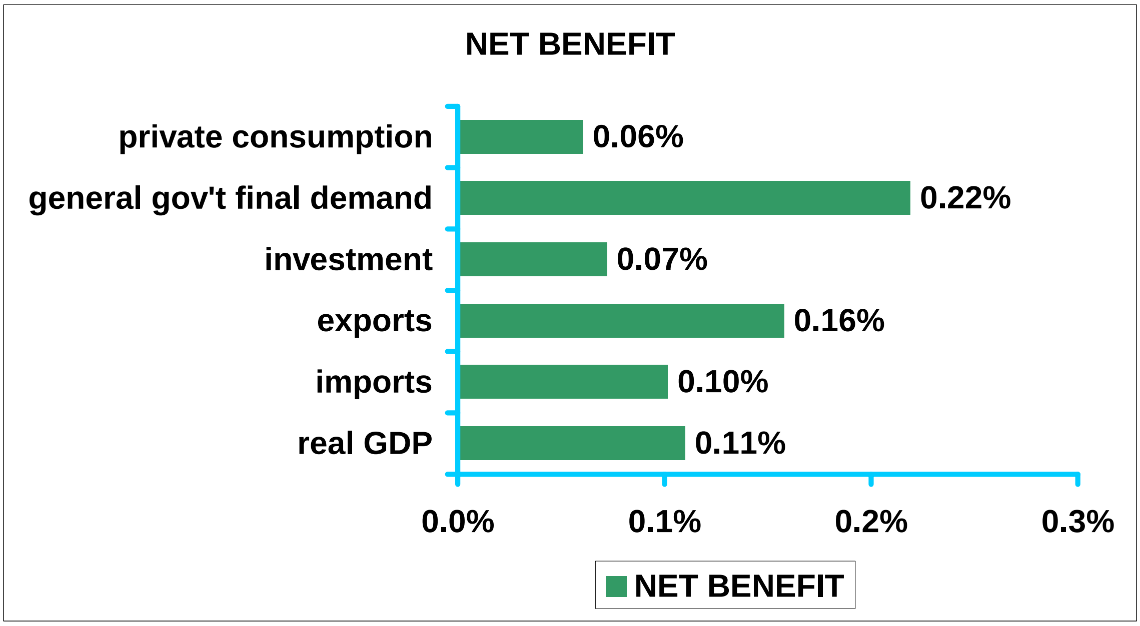
This appendix presents the results of modelling the "BAA 10 per cent Budget Cut Scenario". This scenario reflects a situation where the BAA program exists, but with a smaller budget. Specifically, this scenario assumes that the BAA's budget has been cut by 10 per cent.

Chart D.1 shows the main average annual national macroeconomic effects of this scenario. The effects presented in this chart are the *net* benefits. Therefore, these benefits include the increase in labour productivity achieved through the BAA *and* the cost of the program (i.e. the increase in government spending).

Specifically, Chart D.1 shows the effects of having the BAA program with a 10 per cent cut in its budget versus not the BAA program, on real private consumption, real government consumption, real investment, real exports, real imports and real GDP.

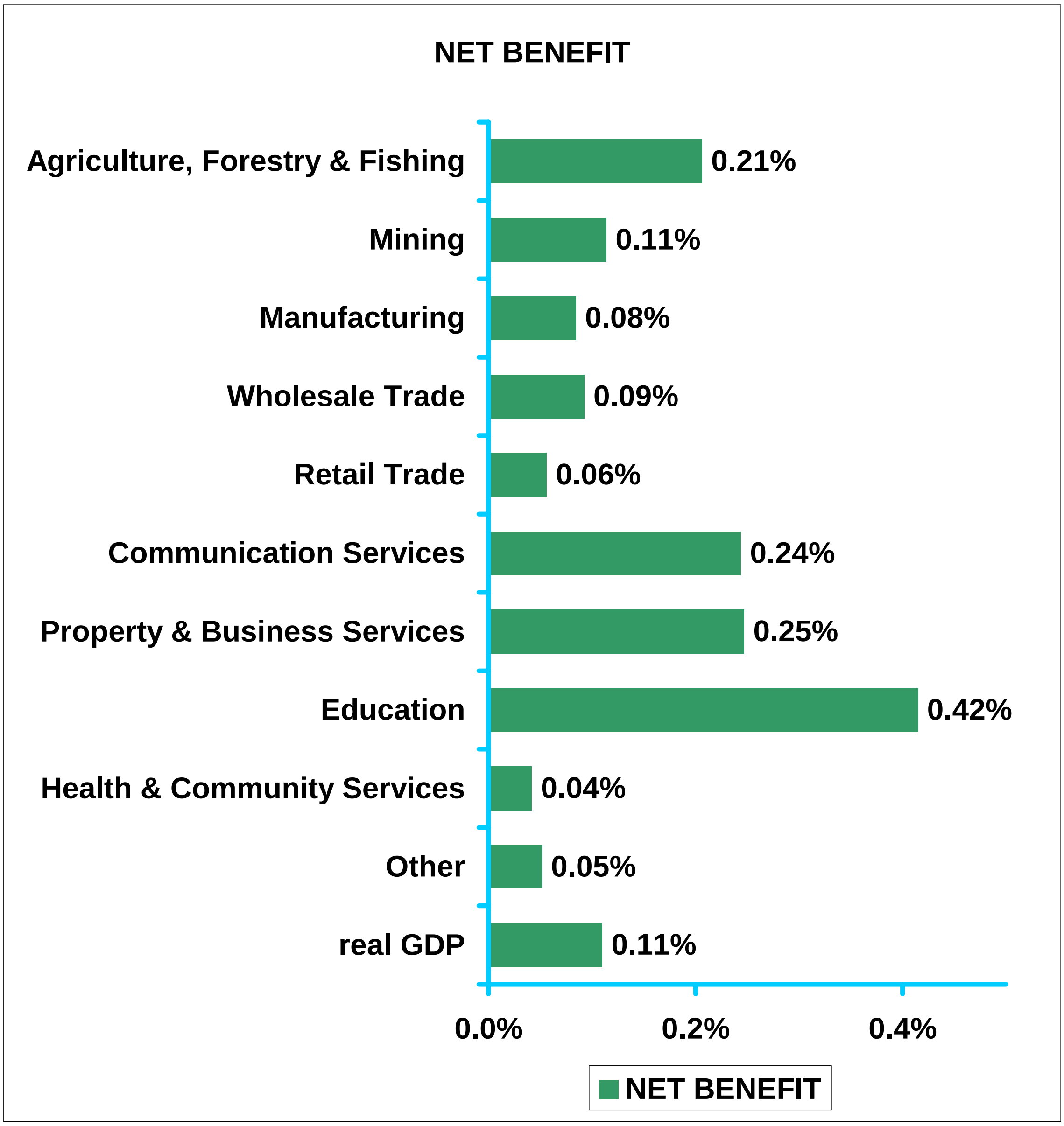
Additionally, Chart D.2 shows the average annual net wider industry effects of the BAA 10 per cent Budget Cut Scenario.

Chart D.1
National Macro-economic Effects
(% deviation from baseline)



Source: Econtech MM600+

Chart D.2
Average Annual Wider Industry Production Effects
(% deviations from baseline)



Source: Econtech MM600+

Attachment E- Additional Scenario 2

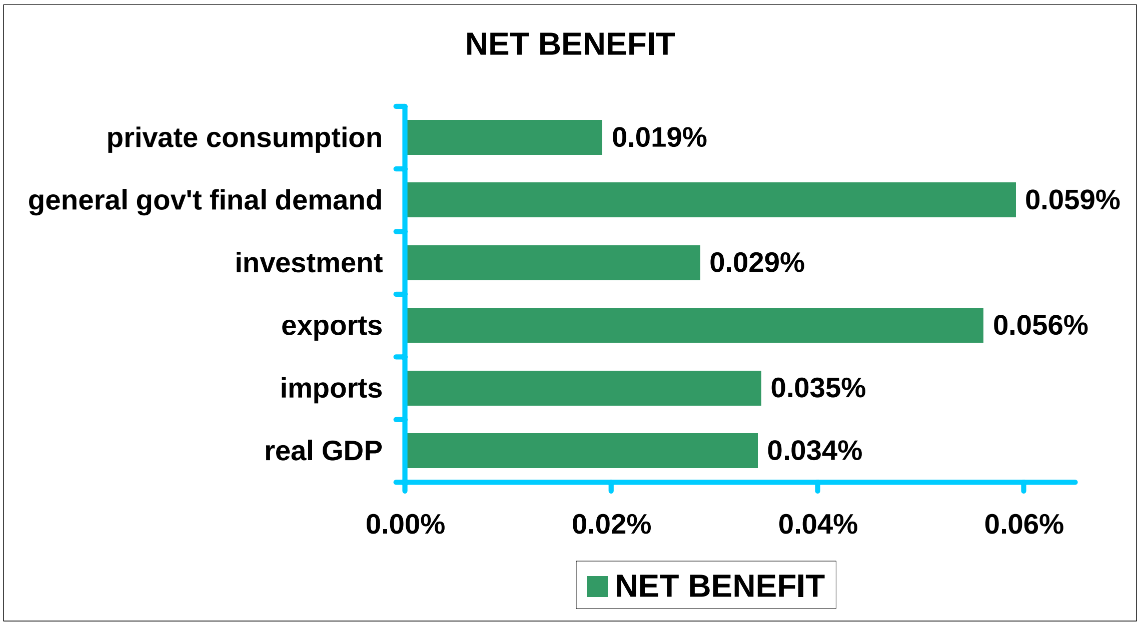
This appendix presents the results of modelling the "NCGP Scenario". This scenario reflects a situation where the only BAA program that exists is the National Competitive Grants Program. Importantly, the NCGP represents only a small part of the BAA program. Indeed, in 2005/06, the NCGP received around 25 per cent of the total BAA funding for that year.

Chart E.1 shows the main average annual national macroeconomic effects of this scenario. The effects presented in this chart are the *net* benefits. Therefore, these benefits include the increase in labour productivity achieved through the BAA *and* the cost of the program (i.e. the increase in government spending).

Specifically, Chart E.1 shows the effects of having the NCGP versus not having the NCGP, on real private consumption, real government consumption, real investment, real exports, real imports and real GDP.

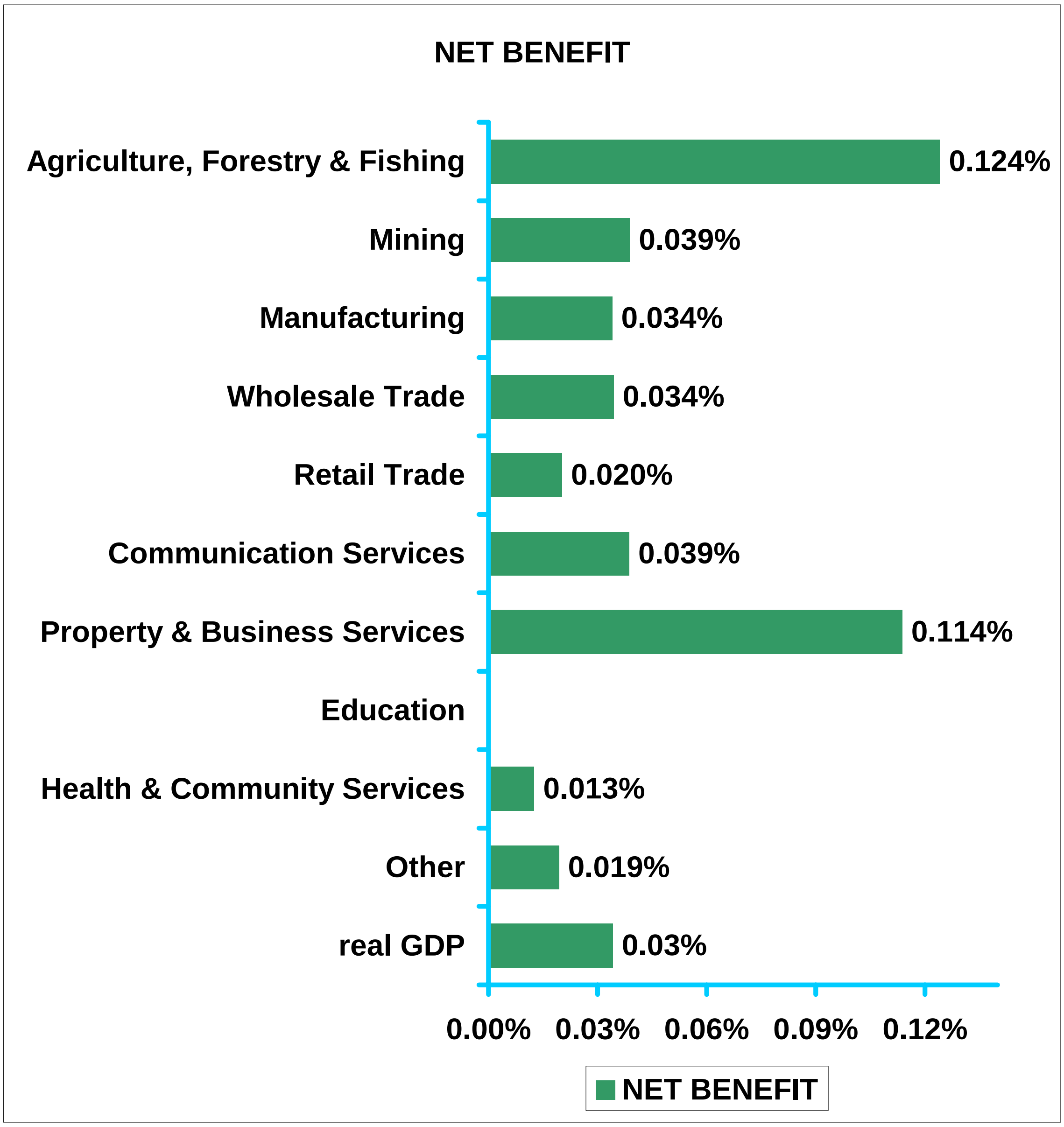
Additionally, Chart E.2 shows the average annual net wider industry effects of the NCGP Scenario.

Chart E.1
National Macro-economic Effects
(% deviation from baseline)



Source: Econtech MM600+

Chart E.2
Average Annual Wider Industry Production Effects
(% deviations from baseline)



Source: Econtech MM600+