Australian Bureau of Statistics

1998–99

8112.0

RESEARCH AND EXPERIMENTAL DEVELOPMENT

ALL SECTOR SUMMARY AUSTRALIA

EMBARGO: 11.30AM (CANBERRA TIME) MON 28 AUG 2000

CONTENTS

■ For further information about these and related statistics, contact the National Information Service on 1300 135 070 or Derek Byars on Canberra 02 6252 5627.

NOTES

RESEARCH AND DEVELOPMENT (R&D) GUIDELINES

Australian Bureau of Statistics (ABS) surveys of R&D are conducted in accordance with standard guidelines promulgated by the Organisation for Economic Co-operation and Development (OECD).

ABBREVIATIONS

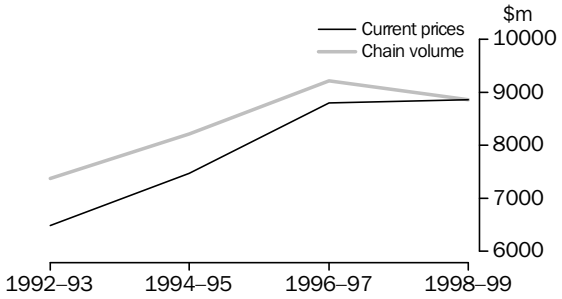
ABS	Australian Bureau of Statistics
ANZSIC	Australian and New Zealand Standard Industrial Classification
FOR	Field of research
GDP	Gross Domestic Product
GERD	Gross Expenditure on R&D
OECD	Organisation for Economic Co-operation and Development
R&D	Research and experimental development
SEO	Socio-economic objective
TKH	Technical know-how

Dennis Trewin
Australian Statistician

GROSS EXPENDITURE ON R&D (GERD)

Gross expenditure on R&D has levelled off in 1998–99 after steadily increasing in the years up to 1996–97. In current price terms, GERD was $8,850m, only marginally higher than in 1996–97. In volume terms, R&D expenditure in 1998–99 decreased by 4% compared with 1996–97.

EXPENDITURE ON R&D



GROSS EXPENDITURE ON R&D

Sector	*1992–93* $m	*1994–95* $m	*1996–97* $m	*1998–99* $m
CURRENT PRICES				
Business	2 861.9	r3 508.3	r4 246.9	3 991.7
Government				
Commonwealth	1 155.4	r1 193.3	r1 264.2	1 192.6
State	668.5	r782.8	r812.7	879.0
Higher education	1 695.2	1 829.6	2 307.6	2 602.7
Private non-profit	101.9	r152.7	r173.4	183.9
Total	**6 482.9**	**r7 466.7**	**r8 804.8**	**8 850.0**
CHAIN VOLUME MEASURES				
Business	3 247.1	3 844.8	4 437.6	3 991.7
Government				
Commonwealth	1 298.9	1 297.7	1 312.6	1 192.6
State	752.2	850.3	842.2	879.0
Higher education	1 957.9	2 042.7	2 435.0	2 602.7
Private non-profit	117.9	170.9	182.6	183.9
Total	**7 374.0**	**8 206.4**	**9 210.0**	**8 850.0**

r revised

In 1998–99, 45% of GERD in current prices was expended in the Business sector, 29% in the Higher education sector, 23% in the Government sector and 2% in the Private non-profit sector. By comparison, in 1996–97, 48%, 26%, 24% and 2% of GERD was expended in these sectors respectively.

GERD AS A PERCENTAGE OF GDP

GERD as a percentage of GDP has fallen from 1.65% in 1996–97 to 1.49% in 1998–99.

GERD AS A PERCENTAGE OF GDP

Australia's GERD/GDP ratio is low compared with other OECD countries. Australia is ranked well below leading industrialised countries such as Japan, United States of America, Korea, Germany and the United Kingdom. Australia's ranking reflects the low R&D expenditure to GDP ratio of the Business sector.

GERD/GDP RATIOS OF OECD COUNTRIES

	1996–97	*1998–99*
Country	%	%
Japan	2.83	3.06
Finland	2.54	2.90
United States of America	2.66	2.74
Korea	2.60	2.52
Germany	2.26	2.29
France	2.30	2.18
Iceland	na	2.01
Denmark	1.85	1.92
United Kingdom	1.92	1.83
Canada	1.60	1.64
Austria	1.57	1.63
Australia	**1.65**	**1.49**
Czech Republic	1.03	1.26
Italy	1.01	1.02
Spain	0.83	0.90
Poland	0.72	0.73
Hungary	0.65	0.68

na not available

HUMAN RESOURCES DEVOTED TO R&D

In 1998–99, 90,717 person years were devoted to R&D, roughly the same as in 1996–97. The majority of these resources were expended by Higher education organisations (50%), Businesses (27%), and Government organisations (21%).

In the period 1992–93 to 1998–99, human resources devoted to R&D increased by 14% or 11,207 person years. Over this period, human resources increased steadily in the Higher education sector and fell steadily in the Commonwealth government sector. In both the Business and Private non-profit sectors, human resources increased between 1992–93 and 1996–97, before falling in 1998–99. In the State government sector, human resources fell between 1992–93 and 1994–95, but has increased since.

HUMAN RESOURCES DEVOTED TO R&D *continued*

HUMAN RESOURCES DEVOTED TO R&D

Sector	*1992–93* person years	*1994–95* person years	*1996–97* person years	*1998–99* person years
Business	22 919	25 812	r26 498	24 201
Government				
Commonwealth	11 019	r10 660	r10 343	9 449
State	8 785	r8 649	r9 045	9 497
Higher education	35 418	40 096	42 739	45 502
Private non-profit	1 369	r1 666	r2 171	2 068
Total	**79 510**	**r86 883**	**r90 795**	**90 717**

r revised

TYPE OF EXPENDITURE

Current expenditure accounted for 91% of gross R&D expenditure, with capital expenditure accounting for the remaining 9%. Labour costs accounted for 45% of total expenditure.

Other current expenditure was the main component (48%) of expenditure by the Business sector, down from 49% in 1996–97. Labour costs accounted for 40%, up from 38% in 1996–97.

Labour costs continued to be the main component of Government R&D expenditure (52%), up from 49% in 1996–97. Capital expenditure accounted for 8%, down from 13% in 1996–97.

Current expenditure accounted for 93%, up from 92% in 1996–97, of Higher education R&D expenditure. Labour costs accounted for 47% of total expenditure.

SOURCE OF FUNDS

The major sources of funds for R&D expenditure in Australia in 1998–99 were Businesses 45% ($3,983m), down from 48% in 1996–97, and Commonwealth government 40% ($3,498m), up from 38% in 1996–97. State government as a source of funds provided 8%, the same as in 1996–97. Private non-profit and other Australian provided 5%, up from 4% in 1996–97. Overseas (2%) maintained the same proportion as in 1996–97. In 1988–89, the sectors provided 33%, 49%, 15%, 3% and 1% of funding respectively.

TYPE OF ACTIVITY

Experimental development remained the predominant activity on which R&D funds were expended, accounting for 40% ($3,551m) of gross expenditure on R&D, up from 39% in 1996–97. Applied research accounted for 33% of gross R&D expenditure in 1998–99, down from 35% in 1996–97. Strategic basic research accounted for 15%, as it did in 1996–97, and Pure basic research accounted for 12%, up from 11% in 1996–97.

In 1998–99, the Higher education sector undertook 84% ($866m) of expenditure on Pure basic research and 49% ($657m) of expenditure on Strategic basic research, and was the main contributor to both of these activities. The Government sector undertook 40% ($1,156m) of expenditure on Applied research and was the major contributor to this activity. The Business sector undertook 86% of Experimental development activity with expenditure of $3,058m.

LOCATION OF EXPENDITURE

The leading States in terms of location of gross R&D expenditure in 1998–99 were New South Wales at $2,662m and Victoria at $2,593m, accounting for 30% and 29% of total expenditure on R&D respectively. Next in order were Queensland (13%), Western Australia (9%) and South Australia (8%).

EXPENDITURE BY SOCIO-ECONOMIC OBJECTIVE (SEO)

In 1998–99, 60% ($5,266m) of R&D expenditure was directed towards Economic development. Society accounted for a further 14% of R&D expendture, followed by Advancement of knowledge (14%), Environment (8%) and Defence (4%). Within Economic development, 41% ($2,140m) of R&D expenditure was directed towards Manufacturing.

Economic development accounted for the majority of expenditure on R&D in the Business sector with 88%, in the Commonwealth government sector with 54%, and in the State government sector with 57%.

The Higher education sector directed 42% of total Higher education R&D expenditure towards Advancement of knowledge.

In the Private non-profit sector, Society accounted for 93% of total Private non-profit expenditure.

EXPENDITURE BY FIELD OF RESEARCH (FOR)

Of the expenditure on R&D activity by all sectors in 1998–99, 91% was directed towards Natural sciences, technologies and engineering and 9% towards Social sciences and humanities.

The bulk of the Business sector's R&D expenditure was in Information, computers and communication technologies (35%), General engineering (28%) and Applied sciences and technologies (20%).

The Fields of research (FOR) in which most Commonwealth government expenditure occurred were Agricultural sciences (16%), Applied sciences and technologies (14%), Earth sciences (14%), and General engineering (13%).

State government expenditure on R&D was predominantly expended in Agricultural sciences (54%), Medical and health sciences (19%) and Biological sciences (13%).

The FORs in which most higher education expenditure occurred were Medical and health sciences (23%), Social sciences (19%), Biological sciences (12%) and Humanities (8%).

The majority of the Private non-profit sector's R&D expenditure was in Medical and health sciences (68%) and Biological sciences (22%).

TYPE OF EMPLOYEE

Total person years of effort for 1998–99 was 90,717, a decrease of 78 person years on 1996–97. The effort by researchers increased by 2% from 61,098 to 62,250 person years, while that of Technicians and Other supporting staff decreased by 4% from 29,697 to 28,466 person years.

Researchers were the predominant type of employee in total person years for all sectors, accounting for approximately 84% of Higher education person years, 58% of Business person years, 47% of Government person years, and 56% of Private non-profit person years of effort.

HUMAN RESOURCES BY SEO

Of the total person years expended on R&D, Economic development accounted for 45%, Advancement of knowledge for 24%, Society for 20%, Environment for 8% and Defence for 3%. This pattern is noticeably different to that for expenditure reflecting the fact that average R&D expenditure per person year of effort differs across the sectors. In particular, it is considerably lower for the Higher education sector because a major part of the R&D is carried out by postgraduates and the research is generally directed towards less capital intensive objectives.

HUMAN RESOURCES BY FOR

Natural sciences, technologies and engineering accounted for 81% of human resource effort, with Social sciences and humanities accounting for the remainder.

The majority of the Business sector's human resource effort was in Information, computers and communication technologies (38%), General engineering (25%) and Applied sciences and technologies (19%).

The Commonwealth government sector's human resource effort was mainly directed towards Agricultural sciences (16%), Applied sciences and technologies (15%) and General engineering (13%).

The FORs in which most State government human resource effort occurred were Agricultural sciences (48%), Medical and health sciences (28%) and Biological sciences (12%).

The Higher education sector devoted 24% of R&D human resources to Social sciences, 19% to Medical and health sciences and 12% to Humanities.

Some 70% of the Private non-profit sector's human resources were devoted to Medical and health sciences and 23% to Biological sciences.

PAYMENTS FOR TKH

Details on payments for TKH were not collected from the Higher education sector. Payments for TKH by the Government, Business and Private non-profit sectors in 1998–99 were estimated to be $444m of which 81% ($358m) were payments made to overseas recipients. These receipts are equivalent to 5.0% and 4.1% of GERD respectively.

Businesses paid $440m for TKH, accounting for 99% of TKH payments.

Total TKH comprised Patent licence fees and royalties (45%) and Other technical know-how (55%).

RECEIPTS FOR TKH

Details on receipts for TKH were not collected from the Higher education sector. Receipts for TKH by the Government, Business and Private non-profit sectors in 1998–99 were estimated to be $318m, of which $164m (52%) were received from overseas. These receipts are equivalent to 3.6% and 1.9% of GERD respectively.

The Business sector received payments of $290m for TKH, accounting for 91% of total receipts.

Receipts for TKH comprised Patent licence fees and royalties (44%) and Other technical know-how (56%).

HEALTH R&D

DEFINITION OF HEALTH R&D

The Australian Standard Research Classification (ASRC) has been used as the basis for determining health R&D. The ASRC is the collective name given to a set of three related classifications, two of which, the Socio-economic Objective classification and the Field of Research classification, can be used to identify health R&D. The use of the Socio-economic Objective classification identifies all R&D with an objective/purpose of health, whereas the use of the Field of Research classification identifies all R&D undertaken using health disciplines.

Socio-economic Objective Classification (SEO)

The following SEO categories may be considered relevant when looking at health R&D:

Group 070400 Human pharmaceutical products which covers R&D directed towards the manufacture of pharmaceutical products for use in the prevention, diagnosis and treatment of human diseases;

Class 071402 Medical instrumentation which covers R&D directed towards the manufacture of medical instrumentation;

Subdivision 130000 Health which covers R&D directed towards human health, including the understanding and treatment of clinical diseases and conditions and the provision of public health and associated support services;

Class 160604 Environmental health which covers R&D directed towards understanding the surroundings of people and environmental issues pertaining to health; and

Group 191000 Advancement of knowledge — Medical and health sciences which covers pure basic research in the medical and health sciences.

R&D by the Business sector is not classified to the most detailed (class) level of the SEO classification. Therefore, for the purposes of this paper, health R&D has been defined in terms of socio-economic objectives as R&D classified to:

Group 070400 Human pharmaceutical products;

Subdivision 130000 Health; or

Group 191000 Advancement of knowledge — Medical and health sciences.

Field of Research Classification (FOR)

When looking at health R&D, the relevant FOR category is the Subdivision 100000 Medical and health sciences. Only R&D which is directly relevant to health and medicine is included in the subdivision. R&D in biological sciences without application to human health and disease is excluded.

HEALTH R&D DEFINED IN TERMS OF SOCIO-ECONOMIC OBJECTIVES

- Expenditure on health R&D was $1,357m in 1998–99, an increase of 15% on 1996–97 and 34% higher than in 1994–95.
- Health R&D expenditure has risen since 1994–95 both as a proportion of total R&D expenditure and as a proportion of Gross Domestic Product (GDP). In 1998–99, health R&D expenditure accounted for 15.4% of total R&D expenditure and 0.23% of GDP.

HEALTH R&D DEFINED IN TERMS OF SOCIO-ECONOMIC OBJECTIVES *continued*

- In 1998–99, expenditure on health R&D by the Higher education sector was $651m, accounting for 48% of total health R&D expenditure. The Business sector accounted for 22%, the Government sector 18% and the Private non-profit sector 12%.
- Health R&D was the major R&D activity of the Private non-profit sector making up 88% of total R&D expenditure by that sector in 1998–99. In contrast, only 8% of total R&D expenditure by the Business sector in 1998–99 was classified as health R&D.
- Human resources devoted to health R&D in 1998–99 were 16,520 person years, an increase of 8% on 1996–97 and 20% higher than in 1994–95.
- In 1998–99, the Higher education sector accounted for 9,471 person years or 57% of the total human resources devoted to health R&D. The Business sector accounted for 11%, the Government sector 20% and the Private non-profit sector 11%.
- In 1998–99, 73% of health R&D expenditure and 79% of human resources devoted to health R&D were directed towards the socio-economic objective of Health, while 16% and 8% respectively were directed towards the socio-economic objective of Human pharmaceutical products, and 11% and 13% respectively towards the Advancement of knowledge in the medical and health sciences.
- The importance of the socio-economic objectives varied across sectors. In the Business sector, the major objective was Human pharmaceutical products accounting for 53% of health R&D expenditure by the sector. The socio-economic objective of Health was the major objective for the other sectors accounting for 96% of health R&D expenditure by the Private non-profit sector, 82% by the Government sector and 78% by the Higher education sector. The Advancement of knowledge in the medical and health sciences accounted for a further 19% of the Higher education sector health R&D expenditure.

HEALTH (SEO) R&D, By Sector

	EXPENDITURE			HUMAN RESOURCES		
	1994–95	*1996–97*	*1998–99*	*1994–95*	*1996–97*	*1998–99*
Sector	$m	$m	$m	person years	person years	person years
Business	226.5	257.2	304.4	1 588	1 740	1 851
Government	253.0	232.0	240.3	3 092	3 248	3 327
Higher education	404.0	537.1	650.8	7 651	8 256	9 471
Private non-profit	132.7	156.9	161.5	1 438	1 989	1 871
Total	**1 016.2**	**1 183.3**	**1 357.1**	**13 769**	**15 233**	**16 520**

HEALTH (SEO) R&D EXPENDITURE

	PROPORTION OF SECTOR R&D EXPENDITURE			PROPORTION OF GDP		
	1994–95	*1996–97*	*1998–99*	*1994–95*	*1996–97*	*1998–99*
Sector	%	%	%	%	%	%
Business	6.5	6.1	7.6	0.05	0.05	0.05
Government	12.8	11.2	11.6	0.05	0.04	0.04
Higher education	22.1	23.3	25.0	0.09	0.10	0.11
Private non-profit	86.9	90.5	87.8	0.03	0.03	0.03
Total	**13.6**	**13.4**	**15.4**	**0.21**	**0.22**	**0.23**

HEALTH R&D DEFINED IN TERMS OF SOCIO-ECONOMIC OBJECTIVES *continued*

HEALTH R&D, By Socio-economic Objective

	EXPENDITURE			HUMAN RESOURCES		
	1994–95	*1996–97*	*1998–99*	*1994–95*	*1996–97*	*1998–99*
Socio-economic objective	$m	$m	$m	person years	person years	person years
070400 Human pharmaceutical products	182.4	197.9	215.8	1 315	1 392	1 403
130100 Clinical (organs, diseases and conditions)	488.2	577.2	643.7	6 820	7 908	8 313
130200 Public health	173.8	195.7	245.5	2 522	2 813	3 128
130300 Health and support services	59.4	88.0	104.7	1 045	1 335	1 529
130000 Health	*721.4*	*860.9*	*993.9*	*10 388*	*12 056*	*12 970*
191000 Advancement of knowledge - Medical and health sciences	112.4	124.5	147.3	2 066	1 783	2 146
Total	**1 016.2**	**1 183.3**	**1 357.1**	**13 769**	**15 233**	**16 520**

HEALTH R&D EXPENDITURE, By Sector and Socio-economic Objective

	Business	*Government*	*Higher education*	*Private non-profit*	*Total*
Socio-economic objective	$m	$m	$m	$m	$m
070400 Human pharmaceutical products	161.4	35.1	18.1	1.3	215.8
130100 Clinical (organs, diseases and conditions)	102.6	124.5	300.0	116.6	643.7
130200 Public health	14.2	47.6	146.4	37.4	245.5
130300 Health and support services	17.6	25.2	60.3	1.6	104.7
130000 Health	*134.3*	*197.2*	*506.7*	*155.6*	*993.9*
191000 Advancement of knowledge - Medical and health sciences	8.7	8.0	126.0	4.7	147.3
Total	**304.4**	**240.3**	**650.8**	**161.5**	**1 357.1**

HEALTH R&D DEFINED IN TERMS OF FIELDS OF RESEARCH

- Expenditure on health R&D was $1,119m in 1998–99, with the Higher education sector accounting for $592m or 53%. The Business sector accounted for 19%, the Government sector 17% and the Private non-profit sector 11%.
- Human resources devoted to health R&D in 1998–99 were 14,059 person years, with the Higher education sector accounting for 8,482 person years or 60%. The Business sector accounted for 9%, the Government sector 20% and the Private non-profit sector 10%.
- In 1998–99, of the $1,119m spent on health R&D, $466m (42%) was in the Clinical services field and $95m (8%) in the field of Pharmacology.
- The fields of Clinical sciences and Public health research were the major fields for expenditure by the Government and Higher education sectors, while for the Business sector major fields were Clinical sciences and Pharmacology and for the Private non-profit sector, Clinical sciences and Immunology.

HEALTH R&D DEFINED IN TERMS OF FIELDS OF RESEARCH *continued*

HEALTH (FOR) R&D, By Sector

	EXPENDITURE			HUMAN RESOURCES		
	1994–95	*1996–97*	*1998–99*	*1994–95*	*1996–97*	*1998–99*
Sector	$m	$m	$m	person years	person years	person years
Business	na	178.3	211.2	na	1 166	1 293
Government	201.3	189.2	189.0	2 551	2 792	2 829
Higher education	375.9	491.4	592.4	7 103	7 575	8 482
Private non-profit	100.5	122.1	125.9	1 115	1 541	1 455
Total	na	**981.0**	**1 118.5**	na	**13 074**	**14 059**

na not available

HEALTH R&D, By Field of Research

	EXPENDITURE		HUMAN RESOURCES	
	1996–97	*1998–99*	*1996–97*	*1998–99*
Sector	$m	$m	person years	person years
100100 Immunology	81.9	83.9	1 149	1 052
100200 Medical biochemistry and clinical chemistry	39.5	31.6	455	351
100300 Medical microbiology	42.6	30.8	603	428
100400 Pharmacology	108.5	94.8	1 013	953
100500 Physiology	np	44.7	np	601
100600 Neurosciences	np	61.9	np	793
100700 Clinical sciences	398.1	466.4	5 532	6 270
100800 Public health research	121.3	np	1 678	np
100900 Health services research	60.5	np	919	np
109900 Other medical and health sciences	31.2	85.6	424	808
100000 Medical and health sciences	**981.0**	**1 118.5**	**13 074**	**14 059**

np not available for publication but included in totals where applicable, unless otherwise indicated

HEALTH R&D DEFINED IN TERMS OF FIELDS OF RESEARCH *continued*

HEALTH R&D EXPENDITURE, By Sector and Field of Research

Field of research	*Business* $m	*Government* $m	*Higher education* $m	*Private non-profit* $m	*Total* $m
100100 Immunology	11.0	15.9	32.1	24.9	83.9
100200 Medical biochemistry and clinical chemistry	8.0	2.8	16.4	4.3	31.6
100300 Medical microbiology	1.9	9.1	13.4	6.4	30.8
100400 Pharmacology	40.7	7.3	45.5	1.4	94.8
100500 Physiology	2.6	4.4	35.0	2.7	44.7
100600 Neurosciences	1.7	2.3	49.1	8.8	61.9
100700 Clinical sciences	84.1	100.6	216.8	64.9	466.4
100800 Public health research	2.1	27.1	100.9	np	np
100900 Health services research	3.5	15.7	60.9	np	np
109900 Other medical and health sciences	55.6	3.8	22.4	3.8	85.6
100000 Medical and health sciences	**211.2**	**189.0**	**592.4**	**125.9**	**1 118.5**

np not available for publication but included in totals where applicable, unless otherwise indicated

LIST OF TABLES

1 GROSS EXPENDITURE, By Type of Expenditure

Sector	Total	Land and buildings	Other capital expenditure	Labour costs(a)	Other current expenditure(b)
	$'000	$'000	$'000	$'000	$'000
			1996–97		
Business	r4 246 864	r34 671	r543 105	r1 595 008	r2 074 080
Government					
Commonwealth	r1 264 186	r111 156	r76 474	r614 680	r461 876
State	r812 732	r48 840	r37 036	r398 456	r328 400
Higher education	2 307 578	47 405	130 967	1 049 143	1 080 064
Private non-profit	r173 397	r8 059	r12 995	r90 043	r62 300
Total	r**8 804 755**	r**250 130**	r**800 577**	r**3 747 330**	r**4 006 719**
			1998–99		
Business	3 991 735	85 992	380 704	1 591 046	1 933 993
Government					
Commonwealth	1 192 615	28 455	72 487	639 233	452 439
State	878 995	29 160	30 287	436 541	383 007
Higher education	2 602 733	34 773	145 472	1 219 277	1 203 211
Private non-profit	183 904	3 483	14 778	92 178	73 465
Total	**8 849 982**	**181 863**	**643 728**	**3 978 275**	**4 046 115**

r revised

(a) Includes wages and salaries, payroll tax, payments to contract staff on the payroll, fringe benefits tax, workers compensation insurance, overtime earnings, shift allowances, penalty rates, bonuses, commission payments, holiday pay, long service leave payments, sick pay, employer contributions to superannuation and pension schemes.

(b) For Higher education sector, includes scholarships for research higher degrees.

2 GROSS EXPENDITURE, By Source of Funds

Sector	Total	Commonwealth government	State and local government	Business	Private non-profit and other Australian(a)	Overseas
	$'000	$'000	$'000	$'000	$'000	$'000
			1996–97			
Business	r4 246 864	r104 031	r4 738	r3 940 907	r61 793	r135 395
Government						
Commonwealth	r1 264 186	r1 106 932	9 100	76 636	61 583	r9 935
State	r812 732	r60 508	r590 533	r42 134	r114 161	r5 395
Higher education	2 307 578	2 033 105	50 977	120 674	78 185	24 637
Private non-profit	r173 397	r49 685	r18 909	r29 650	r69 869	r5 284
Total	r**8 804 755**	r**3 354 262**	r**674 257**	r**4 210 001**	r**385 590**	r**180 646**
			1998–99			
Business	3 991 735	114 035	8 874	3 690 004	46 698	132 124
Government						
Commonwealth	1 192 615	993 611	24 846	71 413	76 610	26 135
State	878 995	77 077	610 049	58 296	128 770	4 804
Higher education	2 602 733	2 266 026	68 802	135 778	90 907	41 220
Private non-profit	183 904	47 437	22 866	27 318	73 165	13 118
Total	**8 849 982**	**3 498 185**	**735 436**	**3 982 809**	**416 150**	**217 401**

r revised

(a) Includes funds provided via government levies.

3 GROSS EXPENDITURE, By Type of Activity(a)

Sector	Total	*Pure basic research*	*Strategic basic research*	*Applied research*	*Experimental development*
	$'000	$'000	$'000	$'000	$'000
			1996–97		
Business	r4 246 864	r29 484	r174 557	r1 001 472	r3 041 350
Government					
Commonwealth	r1 264 186	r51 102	391 433	r673 050	r148 601
State	r812 732	r48 941	r97 255	r553 706	r112 830
Higher education	2 307 578	786 938	576 429	800 680	143 530
Private non-profit	r173 397	r38 279	r68 560	r48 152	r18 407
Total	**r8 804 755**	**r954 744**	**r1 308 234**	**r3 077 060**	**r3 464 718**
			1998–99		
Business	3 991 735	20 848	119 380	793 697	3 057 812
Government					
Commonwealth	1 192 615	64 689	369 120	565 838	192 968
State	878 995	32 220	128 267	590 358	128 150
Higher education	2 602 733	866 447	657 283	920 441	158 563
Private non-profit	183 904	42 740	78 987	48 886	13 291
Total	**8 849 982**	**1 026 944**	**1 353 036**	**2 919 219**	**3 550 783**

r revised

(a) Data within this classification are subjectively allocated by respondents at the time of reporting, using OECD/ABS definitions. Analysts using this classification should bear the original subjectivity in mind. See paragraph 7 of the Explanatory Notes.

4 GROSS EXPENDITURE, By Location of Expenditure(a)

Sector	Total	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT and Ext. Terr.	Overseas
	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000
1996–97										
Business	r4 246 864	r1 487 441	r1 456 780	r434 392	r196 741	r543 593	r58 901	r16 403	r27 517	25 096
Government										
Commonwealth	r1 264 186	r226 137	311 018	112 212	r172 758	63 700	76 205	12 828	284 794	4 534
State	r812 732	234 181	r161 526	202 915	r72 330	95 502	15 421	r24 952	r3 031	r2 875
Higher education	2 307 578	661 105	485 379	385 634	188 161	226 069	51 527	15 172	294 531	—
Private non-profit	r173 397	r43 203	r107 133	r5 216	3 644	r12 059	82	r2	r1 858	r200
Total	r**8 804 755**	r**2 652 067**	r**2 521 835**	r**1 140 368**	r**633 634**	r**940 922**	r**202 137**	r**69 357**	r**611 731**	r**32 704**
1998–99										
Business	3 991 735	1 328 866	1 434 552	439 908	235 080	433 493	39 056	16 509	31 997	32 274
Government										
Commonwealth	1 192 615	234 318	314 595	111 637	177 519	64 263	77 051	14 604	193 600	5 029
State	878 995	249 815	162 310	232 289	90 178	92 439	11 542	33 277	4 065	3 080
Higher education	2 602 733	808 768	557 127	397 671	240 791	225 547	59 417	14 611	298 803	—
Private non-profit	183 904	40 238	124 089	3 955	3 231	10 644	np	—	np	2
Total	**8 849 982**	**2 662 006**	**2 592 674**	**1 185 460**	**746 799**	**826 386**	np	**79 001**	np	**40 384**

r revised

— nil or rounded to zero (including null cells)

np not available for publication but included in totals where applicable, unless otherwise indicated

(a) Location of expenditure. This may not be the location of the organisation's head office.

GROSS EXPENDITURE, By Socio-economic Objective

Socio-economic objective	Total	Business	GOVERNMENT		Higher education	Private non-profit
			Commonwealth	State		
	$'000	$'000	$'000	$'000	$'000	$'000
Defence	*344 924*	*134 070*	*205 051*	—	*5 804*	—
Economic development						
Plant — production and primary products	np	43 741	81 075	271 728	94 220	np
Animal — production and primary products	np	33 822	84 466	152 945	64 707	np
Mineral resources (excl. energy)	468 421	375 263	55 192	4 224	33 742	—
Energy resources	229 079	153 518	58 188	1 071	16 302	—
Energy supply	122 523	84 560	15 943	58	21 951	11
Manufacturing	2 139 956	1 784 699	208 066	28 645	116 991	1 554
Construction	127 333	49 250	28 941	9 483	39 653	6
Transport	119 007	85 313	4 577	14 051	15 067	—
Information and communication services	952 788	819 123	55 582	13 483	64 600	—
Commercial services	128 821	88 099	12 214	878	27 630	—
Economic framework	149 870	1 954	37 153	1 405	109 151	209
Total economic development	*5 266 409*	*3 519 342*	*641 396*	*497 970*	*604 013*	*3 688*
Society						
Health	993 907	134 328	22 017	175 225	506 730	155 608
Education and training	133 431	3 932	1 807	6 527	108 257	12 909
Social development and community services	149 928	20 580	24 035	8 164	95 260	1 889
Total society	*1 277 266*	*158 840*	*47 859*	*189 915*	*710 247*	*170 406*
Environment						
Environmental knowledge	429 707	16 163	210 333	81 220	119 947	2 046
Environmental aspects of economic development	140 846	48 289	39 716	18 558	34 234	50
Environmental management and other aspects	156 168	42 818	26 079	52 841	34 360	71
Total environment	*726 721*	*107 269*	*276 127*	*152 618*	*188 541*	*2 166*
Advancement of knowledge						
Natural sciences, technologies and engineering	909 523	70 914	22 153	35 719	773 093	7 644
Social sciences and humanities	325 139	1 301	30	2 772	321 036	—
Total advancement of knowledge	*1 234 662*	*72 215*	*22 183*	*38 491*	*1 094 129*	*7 644*
TOTAL	**8 849 982**	**3 991 735**	**1 192 615**	**878 995**	**2 602 733**	**183 904**

— nil or rounded to zero (including null cells)

np not available for publication but included in totals where applicable, unless otherwise indicated

6 GROSS EXPENDITURE, By Field of Research

Field of research	Total	Business	GOVERNMENT		Higher education	Private non-profit
			Common-wealth	State		
	$'000	$'000	$'000	$'000	$'000	$'000
Natural sciences, technologies and engineering						
Mathematical sciences	93 080	9 737	18 730	1 556	63 059	—
Physical sciences	227 114	30 805	87 887	934	106 474	1 014
Chemical sciences	311 855	102 268	83 418	3 918	121 038	1 214
Earth sciences	463 970	143 583	169 244	38 113	113 002	29
Information, computers and communication technologies	1 638 776	1 382 025	105 031	12 029	139 173	517
Applied sciences and technologies	1 066 418	779 517	171 763	16 205	98 821	113
General engineering	1 493 309	1 130 351	152 854	27 649	182 275	179
Biological sciences	694 959	86 808	142 525	112 652	311 813	41 161
Agricultural sciences	944 460	109 439	185 560	478 265	170 655	541
Medical and health sciences	1 118 516	211 214	22 055	166 911	592 431	125 905
Total natural sciences, technologies and engineering	*8 052 459*	*3 985 746*	*1 139 067*	*858 231*	*1 898 741*	*170 674*
Social sciences and humanities						
Social sciences	596 465	5 231	53 028	18 535	506 524	13 146
Humanities	201 058	757	520	2 228	197 468	84
Total social sciences and humanities	*797 523*	*5 989*	*53 548*	*20 764*	*703 992*	*13 230*
TOTAL	**8 849 982**	**3 991 735**	**1 192 615**	**878 995**	**2 602 733**	**183 904**

— nil or rounded to zero (including null cells)

7 HUMAN RESOURCES DEVOTED TO R&D, By Type of Employee

Sector	*Total* person years	*Researchers* person years	*Technicians* person years	*Other supporting staff* person years
		1996–97		
Business	r26 498	r15 307	r7 504	r3 686
Government				
Commonwealth	r10 343	r4 503	r3 272	r2 569
State	r9 045	r4 627	r3 369	r1 049
Higher education	42 739	35 472	(a)na	(a)7 266
Private non-profit	r2 171	r1 189	r699	r283
Total	r**90 795**	r**61 098**	r**14 844**	r**14 853**
		1998–99		
Business	24 201	14 087	6 957	3 157
Government				
Commonwealth	9 449	3 939	3 525	1 985
State	9 497	4 922	3 510	1 066
Higher education	45 502	38 137	(a)na	(a)7 365
Private non-profit	2 068	1 167	664	238
Total	**90 717**	**62 250**	**14 656**	**13 810**

r revised

na not available

(a) Technicians for the Higher education sector not separately identified. They are included in other supporting staff.

8 HUMAN RESOURCES DEVOTED TO R&D, By Socio-economic Objective

Socio-economic objective	Total	Business	GOVERNMENT .. Commonwealth	GOVERNMENT .. State	Higher education	Private non-profit
	person years	person years	person years	person years	person years	person years
Defence	*2 877*	*903*	*1 887*	—	*86*	—
Economic development						
Plant — production and primary products	np	381	742	2 467	1 399	np
Animal — production and primary products	np	195	696	1 536	1 011	np
Mineral resources (excl. energy)	1 750	882	392	36	441	—
Energy resources	1 095	465	315	10	305	—
Energy supply	1 015	559	124	1	331	—
Manufacturing	15 357	11 604	1 644	262	1 835	11
Construction	1 340	403	219	54	664	—
Transport	1 021	653	40	68	261	—
Information and communication services	6 941	5 299	410	123	1 110	—
Commercial services	1 147	604	89	8	446	—
Economic framework	2 541	21	351	11	2 156	2
Total economic development	*40 646*	*21 066*	*5 020*	*4 575*	*9 959*	*26*
Society						
Health	12 970	898	137	2 788	7 338	1 809
Education and training	2 870	56	12	95	2 613	95
Social development and community services	2 486	265	243	117	1 844	17
Total society	*18 327*	*1 219*	*392*	*3 000*	*11 795*	*1 921*
Environment						
Environmental knowledge	4 379	81	1 424	736	2 107	31
Environmental aspects of economic development	1 424	262	326	223	612	1
Environmental management and other aspects	1 498	209	207	493	587	1
Total environment	*7 301*	*553*	*1 957*	*1 452*	*3 306*	*34*
Advancement of knowledge						
Natural sciences, technologies and engineering	13 052	439	192	446	11 887	88
Social sciences and humanities	8 514	21	1	24	8 468	—
Total advancement of knowledge	*21 566*	*460*	*192*	*471*	*20 355*	*88*
TOTAL	**90 717**	**24 201**	**9 449**	**9 497**	**45 502**	**2 068**

— nil or rounded to zero (including null cells)

np not available for publication but included in totals where applicable, unless otherwise indicated

9 HUMAN RESOURCES DEVOTED TO R&D, By Field of Research

Field of research	Total	Business	GOVERNMENT		Higher education	Private non-profit
			Commonwealth	State		
	person years	person years	person years	person years	person years	person years
Natural sciences, technologies and engineering						
Mathematical sciences	1 292	76	195	23	997	—
Physical sciences	2 379	257	749	9	1 352	12
Chemical sciences	3 375	766	664	47	1 885	14
Earth sciences	3 754	509	1 010	365	1 870	1
Information, computers and communication technologies	12 523	9 221	839	114	2 345	4
Applied sciences and technologies	7 987	4 715	1 425	136	1 709	2
General engineering	10 184	6 002	1 207	160	2 812	3
Biological sciences	8 138	557	1 103	1 120	4 876	482
Agricultural sciences	9 542	726	1 552	4 600	2 659	5
Medical and health sciences	14 060	1 293	177	2 652	8 482	1 455
Total natural sciences, technologies and engineering	*73 234*	*24 124*	*8 921*	*9 226*	*28 985*	*1 978*
Social sciences and humanities						
Social sciences	11 864	65	524	248	10 939	89
Humanities	5 618	12	4	23	5 578	1
Total social sciences and humanities	*17 482*	*77*	*527*	*271*	*16 517*	*90*
TOTAL	**90 717**	**24 201**	**9 449**	**9 497**	**45 502**	**2 068**

— nil or rounded to zero (including null cells)

10 PAYMENTS FOR TECHNICAL KNOW-HOW(a)

Sector	Total	TYPE OF TECHNICAL KNOW-HOW		LOCATION OF RECIPIENT	
		Patent licence fees and royalties	Other technical know-how	Australia	Overseas
	$'000	$'000	$'000	$'000	$'000
Business	439 531	196 604	242 927	81 813	357 718
Government					
Commonwealth	1 402	1 070	332	1 075	327
State	2 728	252	2 476	2 428	300
Private non-profit	463	292	171	373	90
Total	**444 124**	**198 218**	**245 906**	**85 689**	**358 435**

(a) Payments for technical know-how are not available for the Higher education sector.

11 RECEIPTS FOR TECHNICAL KNOW-HOW(a)

		TYPE OF TECHNICAL KNOW-HOW		LOCATION OF PAYING ORGANISATION	
	Total	*Patent licence fees and royalties*	*Other technical know-how*	*Australia*	*Overseas*
Sector	$'000	$'000	$'000	$'000	$'000
Business	289 596	116 842	172 754	134 601	154 995
Government					
Commonwealth	12 516	10 290	2 226	10 473	2 043
State	8 299	5 050	3 249	6 468	1 831
Private non-profit	7 250	7 037	213	1 683	5 567
Total	**317 661**	**139 219**	**178 442**	**153 225**	**164 436**

(a) Receipts for technical know-how are not available for the Higher education sector.

EXPLANATORY NOTES

INTRODUCTION

1 This publication presents summary statistics of expenditure and human resources devoted to R&D carried out in Australia by businesses/organisations within the Business, Government and Private non-profit sectors during 1998-99 and the Higher education sector during the 1998 calendar year.

2 Statistics are also included for payments and receipts for technical know-how.

3 The statistics presented in this publication have previously been published (at a more detailed level) on an individual sector basis (see paragraph 17).

DATA SOURCES

4 Information relating to data sources for the individual sectors is contained in the individual sector publications (see paragraph 17).

5 The GDP figures used to derive GERD/GDP ratios are current at the time of manuscript finalisation (*Australian National Accounts: National Income, Expenditure and Product, March Quarter 2000*, (Cat. no. 5206.0)), and, at current prices, are as follows: $427,281m (1992–93); $474,546m (1994–95); $533,632m (1996–97); and $594,933m (1998–99). The available GERD/GDP ratios for other OECD countries are current at the time of manuscript finalisation and are sourced from *Main Science and Technology Indicators, 2000-1*, OECD, Paris, 2000.

DEFINITIONS

6 R&D is defined in accordance with the OECD standard as comprising creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

7 Type of R&D activity (TOA) comprises pure basic research, strategic basic research, applied research and experimental development. Data in this classification are subjectively allocated by respondents at the time of reporting, using OECD/ABS definitions. The ABS makes every effort to ensure correct and consistent interpretation and reporting of this data and applies consistent processing methodologies. Analysts using this classification should bear the original subjectivity in mind.

8 For a more comprehensive interpretation of the definition of R&D activity, contact the ABS or refer to the OECD publication, *The Measurement of Scientific and Technological Activities ('Frascati Manual' 1993)*, OECD, Paris, 1994.

SCOPE

9 The sector classification used in the compilation of these statistics is adapted from the guidelines specified by the OECD for use in the conduct of R&D surveys.

10 Four sectors are recognised:

- Business - includes all businesses whose primary activity is the production of goods or services for sale to the general public at a price intended to cover at least the cost of production, and the private non-profit institutions mainly serving them.
- Government — includes all Commonwealth, State and local government departments and authorities.
- Higher education — is defined by the OECD as including all universities and other institutions of post-secondary education whatever their source of finance or legal status.
- Private non-profit — includes private or semi-public incorporated organisations which are established with the intention of not making a profit.

COVERAGE

11 Exclusions from the survey are:

- Business sector for the R&D surveys excludes businesses mainly engaged in Agriculture, forestry, and fishing (i.e. industries in Division A of the Australian and New Zealand Standard Industrial Classification (ANZSIC), 1993 (1292.0)), partly because of collection difficulties and partly because such businesses are believed to have very low R&D activity (agricultural R&D activity is generally carried out by specialised research institutes not included in ANZSIC Division A).
- Government sector excludes local government organisations because it is considered that their contribution to total R&D activity would be minimal. Public sector organisations mainly engaged in higher education (e.g. universities) are included in the Higher education sector whilst those mainly engaged in trading or financial activities are included in the Business sector.
- Higher education sector for the R&D surveys only includes universities. Technical and Further Education colleges and other post secondary institutions are excluded because it is considered that their contribution to total R&D activity would be minimal.

SOCIO-ECONOMIC OBJECTIVE AND FIELD OF RESEARCH CLASSIFICATIONS

12 Statistical information for the Business, Government, Higher education and Private non-profit sectors is classified by both Socio-economic objective (SEO) and Field of research (FOR). For more information on these classifications see the *Australian Standard Research Classification, 1993* (Cat. no. 1297.0).

COMPARABILITY WITH PREVIOUS STATISTICS

13 The statistics for Higher education presented in this publication may not be strictly comparable due to changes in collection methodology. The 1994, 1996 and 1998 statistics were compiled from data collected by the ABS, whereas the 1992 statistics were compiled from data collected from universities by the (then) Department of Employment, Education, Training and Youth Affairs (DEETYA).

CHAIN VOLUME MEASURES

14 The chain volume measures appearing in this publication are annually reweighted chain Laspeyres indexes referenced to the current price values in a chosen year (currently 1998–99). They can be thought of as current price values re-expressed in (i.e. based on) the prices of the previous year and linked together to form continuous time series. They are formed in a multistage processes of which the major steps are described in Section 15 of the information paper, *Introduction of Chain Volume Measures in the Australian National Accounts* (Cat. no. 5248.0).

RELIABILITY OF STATISTICS

15 The statistics in this publication should be used with caution for the following reasons:

- Many data providers had to make estimates because their accounts do not separately record data on R&D activity or receipts and payments for technical know-how.
- The OECD standard definition of R&D used in this survey differs in some respects from what respondents may regard as R&D activity, particularly since the definitions used within the Grants for Industry R&D scheme for the allocation of grants, and the 125% Tax Concession Scheme for tax deductibility for specific R&D activities undertaken within Australia, differ slightly from the R&D survey definition.

UNPUBLISHED STATISTICS

16 Limited additional detailed R&D statistics are available at a charge from the ABS.

RELATED PUBLICATIONS

17 Users may also wish to refer to the following publications:
Australian Standard Research Classification (ASRC), 1993 (Cat. no. 1297.0)

RELATED PUBLICATIONS *continued*

Main Science and Technology Indicators 2000-1, OECD, Paris, 2000

Research and Experimental Development, Businesses, Australia, 1998-99 (Cat. no. 8104.0)

Research and Experimental Development, Government and Private Non-profit Organisations, Australia, 1998-99 (Cat. no. 8109.0)

Research and Experimental Development, Higher Education Organisations, Australia, 1998 (Cat. no. 8111.0)

The Measurement of Scientific and Technological Activities ('Frascati Manual' 1993) OECD, Paris, 1994

18 Current publications issued by the ABS are listed in the *Catalogue of Publications and Products* (Cat. no. 1101.0). The ABS also issues, on Tuesdays and Fridays, a *Release Advice* (Cat. no. 1105.0) which lists publications to be released in the next few days. The Catalogue and Release Advice are available from any ABS office.

ROUNDING

19 Where figures have been rounded, discrepancies may occur between sums of the component items and totals.

GLOSSARY

Applied research	Original work undertaken in order to acquire new knowledge with a specific application in view. It is undertaken either to determine possible uses for the findings of basic research or to determine new methods or ways of achieving some specific and predetermined objectives.
Basic research	Experimental and theoretical work undertaken primarily to acquire new knowledge without a specific application in view. It consists of pure basic research and strategic basic research. Pure basic research is carried out without looking for long-term benefits other than the advancement of knowledge. Strategic basic research is directed into specified broad areas in the expectation of useful discoveries. It provides the broad base of knowledge for the solution of recognised practical problems.
Capital expenditure	Expenditure on the acquisition of fixed tangible assets such as land, buildings, vehicles, plant, machinery and equipment attributable to R&D activity.
Current expenditure	Expenditure on labour costs, materials, fuels, rent, leasing, repairs, maintenance and data processing etc. and the proportion of expenditure on general services and overheads which is attributable to R&D activity.
Experimental development	Systematic work, using existing knowledge gained from research or practical experience, for the purpose of creating new or improved products/processes.
Field of research	Field in which the R&D activity was performed. The FOR classification is primarily structured around disciplines or activities. It describes what research is being performed.
Gross expenditure on R&D	The sum of intramural R&D expenditures incurred by all organisations in the survey.
Human resources devoted to R&D	The effort of researchers, technicians and other staff directly involved with R&D activity. Overhead staff (e.g. administrative and general service employees such as personnel officers, janitors etc.) whose work indirectly supports R&D, are excluded.
Labour costs	Wages and salaries, overtime allowances, penalty rates, leave loadings, bonuses, commission payments, all paid leave, employer contributions to superannuation and pension schemes, payroll tax, fringe benefits tax, payments to contract staff on the payroll, severance, termination and redundancy payments and workers compensation insurance.
Other current expenditure	Expenditure on materials, fuels, rent, hiring, repairs, maintenance and data processing etc. and the proportion of expenditure on general services and overheads which is attributable to R&D activity.
Other supporting staff	Skilled and unskilled craftspersons, secretarial and clerical staff directly associated with R&D activity.
R&D activity	Systematic investigation or experimentation involving innovation or technical risk, the outcome of which is new knowledge, with or without a specific practical application, or new or improved products, processes, materials, devices or services. R&D activity extends to modifications to existing products/processes. R&D activity ceases and pre-production begins when work is no longer experimental.
Researchers	Those involved with the conception and/or development of new knowledge, products, processes, methods and systems, and in the management of the projects concerned.
Socio-economic objective	The area of expected national benefit rather than the immediate objectives of the researcher. The SEO classification defines the main areas of Australian economic and social activity to which the results of research programs are applied. It describes the purpose of the research; i.e. why the research is being performed.

Technical know-how (TKH) Specialised technical knowledge required to successfully produce a product or implement a process, etc. (e.g. patent licences; technical data and information; scientific, technical or engineering assistance) that increases technical knowledge and understanding in an organisation. Payments are those made directly to the holders of TKH which is new to an organisation. They exclude non-monetary transfers, and costs incurred by an organisation in obtaining TKH, such as overseas travel costs.

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

Type of R&D activity Comprises basic research, applied research and experimental development.

FOR MORE INFORMATION...

INTERNET	**www.abs.gov.au** the ABS web site is the best place to start for access to summary data from our latest publications, information about the ABS, advice about upcoming releases, our catalogue, and Australia Now—a statistical profile.
LIBRARY	A range of ABS publications is available from public and tertiary libraries Australia-wide. Contact your nearest library to determine whether it has the ABS statistics you require, or visit our web site for a list of libraries.
CPI INFOLINE	For current and historical Consumer Price Index data, call 1902 981 074 (call cost 77c per minute).
DIAL-A-STATISTIC	For the latest figures for National Accounts, Balance of Payments, Labour Force, Average Weekly Earnings, Estimated Resident Population and the Consumer Price Index call 1900 986 400 (call cost 77c per minute).

INFORMATION SERVICE

Data which have been published and can be provided within five minutes are free of charge. Our information consultants can also help you to access the full range of ABS information—ABS user-pays services can be tailored to your needs, time frame and budget. Publications may be purchased. Specialists are on hand to help you with analytical or methodological advice.

PHONE	**1300 135 070**
EMAIL	**client.services@abs.gov.au**
FAX	1300 135 211
POST	Client Services, ABS, GPO Box 796, Sydney 1041

WHY NOT SUBSCRIBE?

ABS subscription services provide regular, convenient and prompt deliveries of ABS publications and products as they are released. Email delivery of monthly and quarterly publications is available.

PHONE	1300 366 323
EMAIL	subscriptions@abs.gov.au
FAX	03 9615 7848
POST	Subscription Services, ABS, GPO Box 2796Y, Melbourne 3001

2811200007984
ISSN 0729-5022

RRP $19.00

Produced by the Australian Bureau of Statistics