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RESEARCH AND EXPERIMENTAL DEVELOPMENT BUSINESS ENTERPRISES, AUSTRALIA 1990-91

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INQUIRIES

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- *for further information about constant price estimates* contact Alan Tryde on Canberra (06) 252 6801.
- *for information about other ABS statistics and services* please refer to the back page of this publication.

SUMMARY OF FINDINGS

R&D Expenditure

Business expenditure on R&D (BERD) carried out in Australia in 1990-91 is estimated to be $2,017 million at current prices. This represents an increase of 2 per cent compared with 1989-90. At average 1984-85 prices, R&D expenditure is estimated to be $1,359 million. This represents a decrease of 2 per cent compared with1989-90.

At average 1984-85 prices, private sector businesses decreased R&D expenditure by 3 per cent over 1989-90, while public sector businesses increased 3 per cent over this period.

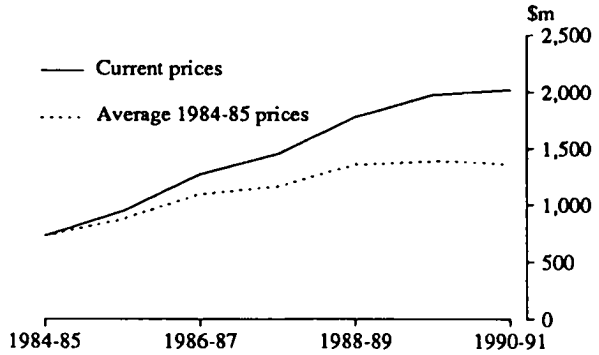
Private sector businesses now account for 90 per cent of R&D expenditure in the business sector. The private sector contribution has been decreasing steadily over the last few years, after reaching a peak in 1987-88 and is now at the same proportion as 1984-85.

Business expenditure on R&D (BERD) represents 0.53 per cent of Gross Domestic Product (GDP). This ratio increased fairly rapidly in the early 1980's but started to plateau from 1986-87. It has remained steady over the last couple of years.

Australia has a relatively low BERD/GDP ratio when compared with the other OECD countries shown in the table below.

Switzerland	2.14%
Japan	2.08%
Germany	2.07%
United States	1.90%
Sweden	1.83%
United Kingdom	1.48%
Finland	1.17%
Denmark	0.84%
Italy	0.79%
Canada	0.75%
AUSTRALIA	**0.53%**
Spain	0.49%
Ireland	0.47%

BUSINESS EXPENDITURE ON R&D



BERD AS A PERCENTAGE OF GDP

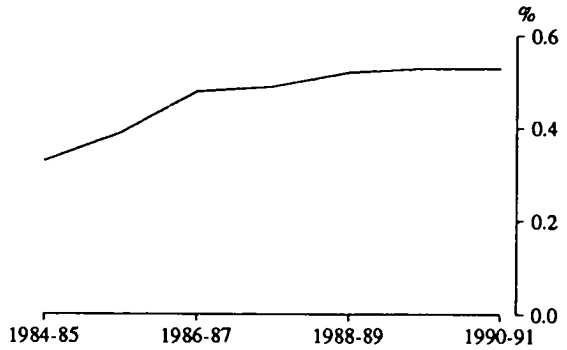


TABLE 1. EXPENDITURE ON R&D BY BUSINESS ENTERPRISES(a), AUSTRALIA
($m)

	1984-85	*1985-86*	*1986-87r*	*1987-88r*	*1988-89r*	*1989-90r*	*1990-91*
AT CURRENT PRICES							
Private Sector	653.7	852.2	1,156.5	1,340.3	1,635.2	1,787.1	1,813.2
Public Sector	77.3	95.7	123.5	117.6	149.2	187.0	204.2
TOTAL BUSINESS ENTERPRISES	**731.1**	**947.9**	**1,280.1**	**1,457.9**	**1,784.4**	**1,974.1**	**2,017.4**
AT AVERAGE 1984-85 PRICES							
Private Sector	653.7	793.7	992.3	1,072.4	1,244.9	1,254.3	1,216.0
Public Sector	77.4	89.2	106.6	97.6	119.3	139.4	143.4
TOTAL BUSINESS ENTERPRISES	**731.1**	**882.9**	**1,098.9**	**1,170.0**	**1,364.2**	**1,393.7**	**1,359.4**

(a) Excludes enterprises in ASIC Division 'A'

Human resources devoted to R&D

Human resources devoted to R&D carried out in Australia is estimated to be 19,985 person years. This represents a 2 per cent decrease over 1989-90. Human resources devoted to research steadily increased over the years to a peak in 1988-89 (20,454 person years), but has declined in the following years.

Private sector businesses account for 91 per cent of person years of effort devoted to R&D in the business sector. This is similar to their contribution to expenditure.

Human resource effort devoted to R&D as a percentage of the number of persons employed by those businesses that carried out R&D has increased to 1.75 per cent in 1990-91, up from 1.37 per cent in 1986-87 and 1.59 per cent in 1988-89.

HUMAN RESOURCES DEVOTED TO R&D

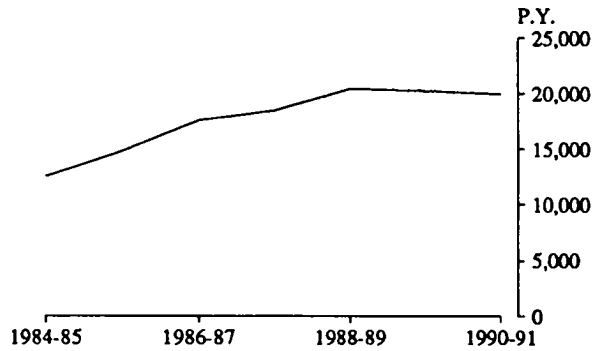


TABLE 2. HUMAN RESOURCES DEVOTED TO R&D BY BUSINESS ENTERPRISES(a), AUSTRALIA
(person years)

	1984-85	*1985-86*	*1986-87r*	*1987-88r*	*1988-89r*	*1989-90r*	*1990-91*
Private Sector	11,324	13,431	16,198	16,952	18,858	18,572	18,103
Public Sector	1,238	1,353	1,393	1,527	1,597	1,729	1,881
TOTAL BUSINESS ENTERPRISES	**12,563**	**14,784**	**17,591**	**18,479**	**20,454**	**20,301**	**19,985**

(a) Excludes enterprises in ASIC Division 'A'

Industry perspective

Enterprises involved in R&D

The number of business enterprises that carried out R&D has decreased by 13 per cent since 1988-89. This decrease occurred in all industries with the exception of Basic metal products. Between 1986-87 and 1988-89 the total number of enterprises carrying out R&D remained fairly constant at just over 3000.

53% of expenditure ($1,060m) and 56 per cent of human resources (11,258 py) were devoted to R&D in the manufacturing sector. The major contributors to this were Appliances and electrical equipment (26% of expenditure, 32% for human resources); Chemicals (17% and 16% respectively) and Transport equipment (17% and 13% respectively).

Outside of manufacturing the largest industry was Property and business services. This contributed 12 per cent each of expenditure and human resources to the total for all business enterprises in Australia.

NUMBER OF ENTERPRISES

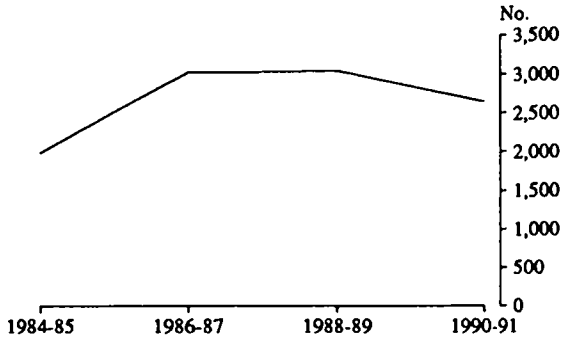


TABLE 3. R&D BY BUSINESS ENTERPRISES(a), AUSTRALIA, BY INDUSTRY OF ENTERPRISE

Industry of enterprise ASIC Code	Description	Enterprises (number)			Expenditure on R & D ($m)			Person years of effort on R & D		
		1986-87r	1988-89r	1990-91	1986-87r	1988-89r	1990-91	1986-87r	1988-89r	1990-91
11-15	**Mining (excluding services to mining)**	**39**	**47**	**42**	**55.6**	**68.7**	**77.3**	**524**	**589**	**559**
	Manufacturing —									
21	Food, beverages and tobacco	107	106	98	58.8	87.4	85.3	883	891	925
23-24	Textiles, clothing and footwear	35	45	30	12.9	9.1	7.5	119	118	74
25	Wood, wood products and furniture	47	47	36	6.4	10.4	7.3	118	122	107
26	Paper, paper products, printing and publishing	32	28	27	10.0	24.1	35.4	158	234	231
27	Chemical, petroleum and coal products	270	258	236	120.1	147.1	178.7	1,857	1,660	1,799
28	Non-metallic mineral products	39	45	33	15.3	22.2	17.5	178	204	159
29	Basic metal products	46	53	57	63.2	91.4	130.5	855	948	969
31	Fabricated metal products	129	133	112	23.0	26.1	32.6	392	382	354
32	Transport equipment	98	123	106	127.9	162.3	155.0	1,562	1,804	1,463
334	Photographic, professional and scientific equipment	67	70	59	25.7	37.5	41.9	433	513	490
335	Appliances and electrical equipment	590	583	571	174.5	236.4	275.1	2,835	3,450	3,605
336	Industrial machinery and equipment	254	259	224	43.3	56.1	60.3	720	799	710
34	Miscellaneous manufacturing	102	118	113	21.6	27.1	32.9	329	400	375
C	**Total manufacturing**	**1,816**	**1,868**	**1,702**	**702.7**	**937.2**	**1060.0**	**10,438**	**11,523**	**11,258**
	Other industries —									
F	Wholesale and retail trade	295	294	260	99.9	159.4	174.2	1,264	1,689	1,629
61-62	Finance	46	51	37	59.0	106.4	124.0	836	1,165	1,271
63	Property and business services	587	524	403	183.6	228.5	249.0	2,413	2,810	2,490
8461	Research and scientific institutions	80	95	63	45.3	127.4	111.2	640	1,094	986
(b)	Other n.e.c.	166	168	146	134.1	156.8	221.8	1,476	1,584	1,791
16, D-L	**Total other industries**	**1,174**	**1,132**	**909**	**521.8**	**778.5**	**880.1**	**6,629**	**8,342**	**8,168**
	TOTAL ALL INDUSTRIES	3,029	3,047	2,653	1280.1	1784.4	2017.4	17,591	20,454	19,985
	Private Sector Contribution	2,968	2,990	2,602	1,156.5	1,635.2	1,813.2	16,198	18,858	18,103
	Public Sector Contribution	61	57	51	123.5	149.2	204.2	1,393	1,597	1,881

(a) Excludes enterprises in ASIC Division 'A' (b) ASIC codes 16,D,E,G,H,J,8141-8306,8462-8495,L.

Type of expenditure

Labour costs continue to be the main component of R&D expenditure (50%). Labour costs have remained at a constant proportion of total R&D costs for a number of years. The Finance industry has the highest labour costs and the lowest capital costs as a proportion of total R&D expenditure.

In the mining sector expenditure on capital assets accounts for a considerably higher proportion of total R&D costs (28%) compared with the manufacturing and other industries (both 12%).

Type of activity

63 per cent of business R&D expenditure is directed towards Experimental development, up from 61 per cent in 1988-89. For the manufacturing sector, 71 per cent of research is on Experimental development and 24 per cent is Applied research. For the mining sector however only 55 per cent is on Experimental development while 42 per cent is Applied research.

Basic research is fairly small in all industries except for Research and scientific institutions where it is 14 per cent of total research, and Other industries (utilities, transport, communications etc) where it is 12 per cent.

TABLE 4. R&D BY BUSINESS ENTERPRISES(a), AUSTRALIA, 1990-91, BY TYPE OF EXPENDITURE AND TYPE OF ACTIVITY ($'000)

Industry of enterprise ASIC Code	*Description*	*Total*	*Type of expenditure*			*Type of activity(b)*		
			Capital expenditure	*Labour costs(c)*	*Other current expenditure*	*Basic research*	*Applied research*	*Experimental development*
11-15	**Mining (excluding services to mining)**	**77,282**	**21,277**	**34,325**	**21,680**	**1,818**	**32,754**	**42,710**
	Manufacturing —							
21	Food, beverages and tobacco	85,252	11,852	42,465	30,935	6,972	19,928	58,351
23-24	Textiles, clothing and footwear	7,469	1,131	3,266	3,073	n.p.	n.p.	4,464
25	Wood, wood products and furniture	7,295	509	4,434	2,353	n.p.	n.p.	4,627
26	Paper, paper products, printing and publishing	35,441	6,265	10,781	18,395	604	6,664	28,173
27	Chemical, petroleum and coal products	178,739	17,742	84,114	76,883	11,247	41,187	126,305
28	Non-metallic mineral products	17,510	2,866	7,355	7,289	757	4,400	12,354
29	Basic metal products	130,529	23,284	49,648	57,598	7,274	60,955	62,300
31	Fabricated metal products	32,646	7,757	14,982	9,907	621	12,720	19,305
32	Transport equipment	154,994	14,454	81,850	58,691	3,709	17,030	134,255
334	Photographic, professional and scientific equipment	41,910	3,822	23,014	15,074	1,820	10,993	29,097
335	Appliances and electrical equipment	275,105	24,969	155,375	94,762	10,897	56,976	207,233
336	Industrial machinery and equipment	60,261	3,556	27,598	29,107	3,471	15,596	41,194
34	Miscellaneous manufacturing	32,883	3,754	16,316	12,813	1,169	4,468	27,246
C	**Total manufacturing**	**1,060,033**	**121,958**	**521,197**	**416,878**	**49,080**	**256,050**	**754,904**
	Other industries —							
F	Wholesale and retail trade	174,160	11,203	90,206	72,752	15,653	52,031	106,477
61-62	Finance	124,012	3,754	82,001	38,258	2,750	64,972	56,290
63	Property and business services	249,007	27,805	120,011	101,192	14,887	55,624	178,496
8461	Research and scientific institutions	111,161	16,520	48,632	46,009	15,423	53,016	42,722
(d)	Other n.e.c.	221,756	42,152	105,925	73,679	27,498	97,456	96,802
16, D-L	**Total other industries**	**880,096**	**101,433**	**446,773**	**331,890**	**76,210**	**323,099**	**480,787**
	TOTAL ALL INDUSTRIES	**2,017,411**	**244,668**	**1,002,295**	**770,448**	**127,108**	**611,903**	**1,278,400**
	Private sector contribution to 'Total all industries' —							
	1990-91	1,813,202	207,883	894,450	710,870	100,501	519,074	1,193,627
	1988-89r	1,635,213	248,840	799,334	587,039	93,239	534,921	1,007,054

(a) Excludes enterprises in ASIC Division 'A' (b) 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 11 of the Explanatory Notes. (c) Includes wages and salaries, payroll tax, payments to contract staff on the payroll, fringe benefits tax and 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. (d) ASIC codes 16,D,E,G,H,J,8141-8306,8462-8495,L.

Source of funds for R&D

Most of the funding for R&D expenditure came from the business sector itself: 88 per cent from own funds and 6 per cent from other business enterprises, totalling $1892m. The industries in which business enterprises provide funds for other business enterprises are mainly Appliances and electrical equipment, Property and business services and Research and scientific institutions. This R&D is generally software development. The next major source of funding was the Commonwealth Government: 1 per cent from the Grants for Industry R&D (GIRD) Scheme and 2 per cent from other Commonwealth Government sources, totalling $67m. 2 per cent or $42m was funded from overseas.

TABLE 5. SOURCE OF FUNDS FOR R&D BY BUSINESS ENTERPRISES(a), AUSTRALIA, 1990-91
($'000)

Industry of enterprise ASIC Code	Description	Total	*Source of funds* Own funds	Other business enterprises	GIRD Scheme(b)	Other C'wealth Gov't	State and Local Gov't	Other Aust(c)	Overseas
11-15	**Mining (excluding services to mining)**	**77,282**	**76,197**	n.p.	n.p.	n.p.	—	—	—
	Manufacturing —								
21	Food, beverages and tobacco	85,252	83,996	n.p.	n.p.	392	n.p.	n.p.	n.p.
23-24	Textiles, clothing and footwear	7,469	7,246	n.p.	n.p.	—	—	—	—
25	Wood, wood products and furniture	7,295	6,200	n.p.	n.p.	—	—	—	—
26	Paper, paper products, printing and publishing	35,441	35,415	n.p.	n.p.	—	—	n.p.	—
27	Chemical, petroleum and coal products	178,739	167,193	n.p.	n.p.	n.p.	—	n.p.	3,254
28	Non-metallic mineral products	17,510	16,990	277	n.p.	n.p.	—	—	—
29	Basic metal products	130,529	126,881	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
31	Fabricated metal products	32,646	32,468	n.p.	128	—	—	n.p.	—
32	Transport equipment	154,994	143,850	n.p.	171	n.p.	189	n.p.	n.p.
334	Photographic, professional and scientific equipment	41,910	40,480	497	639	195	100	—	—
335	Appliances and electrical equipment	275,105	226,040	30,666	6,932	8,693	582	1,096	1,096
336	Industrial machinery and equipment	60,261	57,582	1,237	1,170	n.p.	—	n.p.	—
34	Miscellaneous manufacturing	32,883	29,865	1,849	703	256	n.p.	n.p.	n.p.
C	**Total manufacturing**	**1,060,033**	**974,205**	**44,662**	**11,117**	**20,855**	**1,275**	**2,040**	**5,879**
	Other industries —								
F	Wholesale and retail trade	174,160	145,554	2,042	1,846	832	n.p.	n.p.	23,333
61-62	Finance	124,012	123,257	n.p.	n.p.	n.p.	n.p.	—	n.p.
63	Property and business services	249,007	175,034	45,410	1,833	16,826	3,075	n.p.	n.p.
8461	Research and scientific institutions	111,161	59,860	31,072	693	8,485	774	4,243	6,033
(d)	Other n.e.c.	221,756	213,518	493	641	2,889	3,474	741	—
16, D-L	**Total other industries**	**880,096**	**717,223**	n.p.	n.p.	n.p.	**7,676**	**5,744**	**35,849**
	TOTAL ALL INDUSTRIES	**2,017,411**	**1,767,626**	**124,416**	**16,513**	**50,394**	**8,951**	**7,783**	**41,728**
	Private sector contribution to 'Total all industries' —								
	1990-91	1,813,202	1,572,856	124,115	15,804	45,492	n.p.	n.p.	41,728
	1988-89r	1,635,213	1,406,475	122,602	24,679	34,395	2,709	3,679	40,676

(a) Excludes enterprises in ASIC Division 'A' (b) Grants for Industry R & D Scheme. (c) Includes Higher Education and Private Non-profit sectors. (d) ASIC codes 16,D,E,G,H,J,8141-8306,8462-8495,L.

State comparisons

The leading states in terms of R&D expenditure are New South Wales at $857m and Victoria at $690m, accounting for 42 per cent and 34 per cent of total expenditure respectively. Next in order are Queensland (7%), Western Australia (7%) and South Australia (6%). This ranking is the same as 1989-90.

The main industries undertaking R&D in New South Wales are Appliances and electrical equipment manufacturing, Other industries n.e.c. and the Finance industry. In Victoria they are Appliances and electrical equipment manufacturing; Transport equipment manufacturing and Other industries n.e.c. South Australia's main industry undertaking R&D is Transport equipment manufacturing.

STATE DETAILS

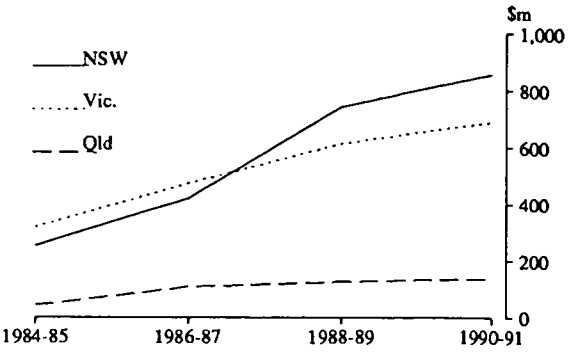


TABLE 6. LOCATION OF R&D EXPENDITURE(a) BY BUSINESS ENTERPRISES(b), AUSTRALIA, 1990-91
($'000)

Industry of enterprise ASIC Code	Description	*Total*	*Location of expenditure* NSW	Vic.	Qld	SA	WA	*Other Australian states and territories*	*Overseas*
11-15	**Mining (excluding services to mining)**	**77,282**	**8,910**	**2,774**	n.p.	**959**	**15,260**	**1,794**	n.p.
	Manufacturing —								
21	Food, beverages and tobacco	85,252	47,063	27,250	6,906	1,453	1,610	970	—
23-24	Textiles, clothing and footwear	7,469	2,491	2,769	n.p.	n.p.	n.p.	n.p.	n.p.
25	Wood, wood products and furniture	7,295	2,625	957	932	1,479	930	n.p.	n.p.
26	Paper, paper products, printing and publishing	35,441	3,873	16,563	589	n.p.	n.p.	n.p.	143
27	Chemical, petroleum and coal products	178,739	72,430	74,197	6,754	7,280	n.p.	n.p.	n.p.
28	Non-metallic mineral products	17,510	8,328	5,978	n.p.	n.p.	1,772	—	—
29	Basic metal products	130,529	51,092	41,062	2,508	3,961	n.p.	n.p.	n.p.
31	Fabricated metal products	32,646	14,732	10,474	3,967	2,830	n.p.	—	n.p.
32	Transport equipment	154,994	20,371	98,447	4,591	27,851	1,912	—	1,822
334	Photographic, professional and scientific equipment	41,910	20,379	17,168	2,674	1,208	n.p.	—	n.p.
335	Appliances and electrical equipment	275,105	109,588	100,932	9,454	27,721	19,689	n.p.	n.p.
336	Industrial machinery and equipment	60,261	27,162	19,887	6,084	2,750	3,472	n.p.	n.p.
34	Miscellaneous manufacturing	32,883	10,330	8,371	2,535	9,410	2,177	n.p.	n.p.
C	**Total manufacturing**	**1,060,033**	**390,463**	**424,053**	**49,082**	**88,643**	**55,726**	**35,564**	**16,502**
	Other industries —								
F	Wholesale and retail trade	174,160	107,121	42,550	13,766	4,103	n.p.	4,136	n.p.
61-62	Finance	124,012	107,657	13,570	n.p.	626	n.p.	n.p.	n.p.
63	Property and business services	249,007	84,520	82,592	17,470	7,414	43,771	6,887	6,354
8461	Research and scientific institutions	111,161	51,034	37,629	11,569	5,211	n.p.	n.p.	n.p.
(c)	Other n.e.c.	221,756	107,680	87,116	8,447	4,756	10,252	2,906	598
16, D-L	**Total other industries**	**880,096**	**458,012**	**263,456**	n.p.	**22,110**	**63,272**	**14,666**	n.p.
	TOTAL ALL INDUSTRIES	**2,017,411**	**857,385**	**690,282**	**139,409**	**111,712**	**134,258**	**52,025**	**32,341**
	Private sector contribution to 'Total all industries' —								
	1990-91	1,813,202	759,893	601,620	132,528	108,523	129,185	n.p.	n.p.
	1988-89r	1,635,213	690,340	534,734	124,502	100,143	93,131	74,623	17,741

(a) Location of the expenditure. This may not be the location of the organisations head office. (b) Excludes enterprises in ASIC Division 'A' (c) ASIC Codes 16,D,E,G,H,J,8141-8306,8462-8495,L.

Directions of R&D effort

$1758m (87%) of R&D effort is applied to manufactured products. $477m of this is directed towards Computer software. Computer software has grown at a considerable rate, (25%) over the two years from 1988-89 to 1990-91. It is now 24 per cent of total R&D expenditure, up from 17% in 1986-87 and 21 per cent in 1988-89. The next largest product areas are Telecommunications and broadcasting equipment (10 per cent of the total) and Motor vehicles and parts (8 per cent of the total) although their positions are reversed from 1988-89. Pharmaceutical products at 4 per cent commands only slightly more effort than Metallic minerals.

MAJOR R&D PRODUCTS

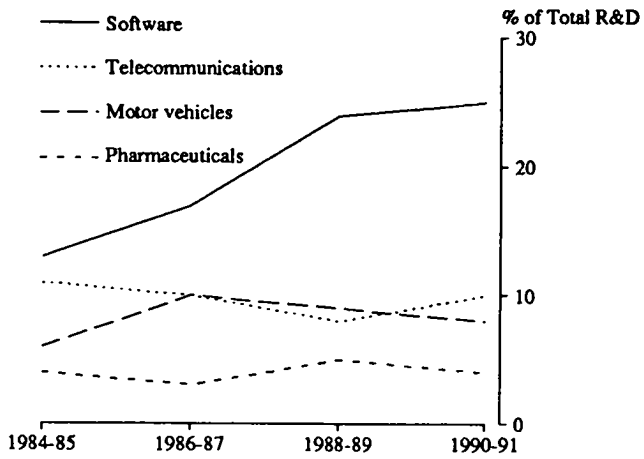


TABLE 7. PRODUCT FIELD(a) OF R&D EXPENDITURE BY BUSINESS ENTERPRISES(b), AUSTRALIA

Industry of product field ASIC Code	*Description*	*1986-87r* Enterprises(c) (number)	*1986-87r* R & D expenditure ($'000)	*1988-89r* Enterprises(c) (number)	*1988-89r* R & D expenditure ($'000)	*1990-91* Enterprises(c) (number)	*1990-91* R & D expenditure ($'000)
	Agriculture,forestry,fishing and hunting —						
012,018	Poultry, cereal grains, sheep, cattle and pigs	12	5,109	27	14,259	36	19,350
013-014, 019-04	Other agriculture, forestry, fishing and hunting	39	7,209	42	9,331	54	9,680
A	**Total agriculture, forestry, fishing and hunting**	**51**	**12,318**	**64**	**23,590**	**86**	**29,030**
	Mining —						
11	Metallic minerals	27	49,909	48	65,467	54	85,893
12-15	Non-metallic minerals	30	30,681	55	41,407	57	38,791
11-15	**Total mining (excluding services to mining)**	**51**	**80,590**	**89**	**106,874**	**98**	**124,684**

See footnotes at end of table.

TABLE 7. PRODUCT FIELD(a) OF R&D EXPENDITURE BY BUSINESS ENTERPRISES(b), AUSTRALIA—*continued*

Industry of product field ASIC Code	*Description*	*1986-87r* Enterprises(c) (number)	*1986-87r* R & D expenditure ($'000)	*1988-89r* Enterprises(c) (number)	*1988-89r* R & D expenditure ($'000)	*1990-91* Enterprises(c) (number)	*1990-91* R & D expenditure ($'000)
	Manufacturing —						
211	Meat products	19	3,798	24	2,437	21	3,100
212	Milk products	16	12,905	26	10,582	30	12,196
213	Fruit and vegetable products	19	1,351	26	2,656	27	4,932
214,217	Margarine, oils, fats n.e.c. and other food products	70	22,574	65	26,077	69	32,105
215,216	Flour mill and cereal food products, bread, cakes and biscuits	18	9,399	33	15,929	28	14,408
218,219	Beverages, malt and tobacco products	19	5,358	32	17,723	24	11,078
21	Total food, beverages and tobacco	138	55,384	146	75,405	143	77,821
234	Textile fibres, yarns and woven fibres	14	1,736	23	4,810	20	4,262
235,24	Other textile products, clothing and footwear	34	4,877	31	3,617	27	3,875
23,24	Total textiles, clothing and footwear	48	6,613	53	8,427	45	8,137
25	Wood, wood products and furniture	65	5,624	62	6,176	48	5,622
263	Paper and paper products	23	n.p.	28	23,398	39	30,746
264	Printing and allied industries	4	n.p.	10	2,833	24	3,745
26	Total paper, paper products, printing and publishing	27	9,086	37	26,231	58	34,491
2751	Chemical fertilizers	13	2,666	12	1,407	15	1,255
2753	Synthetic resins and rubber	54	17,537	42	18,559	46	24,928
2754	Organic industrial chemicals n.e.c.	37	4,624	46	7,260	27	3,587
2755	Inorganic industrial chemicals n.e.c.	51	9,515	30	4,467	24	7,414
2762	Paints	65	12,582	58	15,041	64	19,129
2763	(Veterinary products	31	16,780	34	23,092	36	23,161
	(Pharmaceutical products	77	42,245	98	81,325	81	86,066
2764	Pesticides	29	15,760	37	18,075	28	21,772
2765	Soap and other detergents	36	3,918	36	5,612	32	6,374
2766	Cosmetics and toilet preparations	23	3,202	30	7,778	29	7,006
2767	Inks	12	1,835	7	1,891	9	1,690
2752,2761, 2768	Industrial gases, ammunition and other chemical products	97	20,463	90	17,820	87	24,732
275,276	Total basic chemicals and other chemical products	424	151,127	372	202,329	332	227,113
277,278	Petroleum refining, petroleum and coal products n.e.c.	40	7,800	36	10,540	40	10,504
27	Total chemical, petroleum and coal products	451	158,928	402	212,869	364	237,617
285	Glass and glass products	7	999	15	1,384	17	2,265
286	Clay products and refractories	30	12,930	29	3,513	24	4,899
287	Cement and concrete products	28	6,084	31	7,695	29	7,072
288	Other non-metallic mineral products	30	3,462	34	26,948	24	12,404
28	Total non-metallic mineral products	85	23,475	96	39,540	83	26,641
294	Basic iron and steel	65	45,077	44	59,699	44	64,958
295,296	Basic non-ferrous metals	53	26,835	49	34,287	54	43,289
29	Total basic metal products	114	71,911	84	93,986	89	108,247
314	Structural metal products	59	6,186	60	9,615	59	15,937
315	Sheet metal products	35	4,811	64	10,516	70	13,145
316	Other fabricated metal products	126	14,666	119	23,041	141	32,651
31	Total fabricated metal products	209	25,664	217	43,173	238	61,734
323	Motor vehicles and parts	112	126,279	119	158,641	106	153,905
3241,3242	Ships and boats	23	5,157	29	5,435	17	1,429
3243	Railway rolling stock and locomotives	12	8,693	16	3,430	12	1,632
3244	Aircraft	12	2,685	20	6,996	20	14,764
3245	Transport equipment n.e.c.	12	1,601	25	3,721	34	4,853
324	Total other transport equipment	58	18,137	83	19,582	78	22,678
32	Total transport equipment	163	144,415	194	178,223	172	176,582
3341,3342	Photographic and optical goods and photographic film processing	26	6,711	27	5,473	16	4,937
3343	(Medical and surgical equipment (excl. veterinary equipment)	63	22,548	73	34,705	51	30,762
	(Other measuring, professional and scientific equipment	85	13,505	99	26,558	89	21,736
334	Total Photographic, professional and scientific equipment	171	42,765	186	66,736	145	57,434
3351	Radio and TV receivers and audio equipment	37	2,904	38	3,477	28	3,240

See footnotes at end of table.

TABLE 7. PRODUCT FIELD(a) OF R&D EXPENDITURE BY BUSINESS ENTERPRISES(b), AUSTRALIA—*continued*

Industry of product field ASIC *Code*	*Description*	*1986-87r* Enter-prises(c) (number)	*1986-87r* R & D expend-iture ($'000)	*1988-89r* Enter-prises(c) (number)	*1988-89r* R & D expend-iture ($'000)	*1990-91* Enter-prises(c) (number)	*1990-91* R & D expend-iture ($'000)
	(Telecommunications and broadcasting						
	(equipment	138	132,614	123	150,223	95	200,723
3352	(Other electronic equipment	226	32,240	223	44,408	196	38,663
	(Computer hardware	231	45,273	190	42,556	180	38,810
	(Computer software	576	215,838	580	382,802	565	476,821
3353	Refrigerators and household appliances	68	13,853	56	17,050	35	19,768
3354	Water heating systems	22	4,059	23	3,322	17	4,415
3355—	Cables, batteries and other electrical						
3357	machinery and equipment n.e.c.	246	31,637	169	30,274	114	26,409
335	Total appliances and electrical equipment	1,279	478,417	1,122	674,111	949	808,848
3361	Agricultural machinery	83	10,193	79	10,683	50	7,363
3362	Construction machinery	12	2,968	21	5,053	20	1,255
3363	Materials handling equipment	63	6,149	54	7,113	54	16,637
3364	Wood and metal working machinery	48	5,416	39	10,792	24	4,861
3365	Pumps and compressors	33	3,320	35	4,374	27	2,152
3366	Commercial space heating and cooling equipment	28	5,184	28	4,252	21	3,050
3367	Dies, saw blades and machine tool accessories	5	112	8	2,315	16	1,382
3368	Food processing equipment	49	10,598	39	11,603	33	11,589
3369	Industrial machinery & equipment n.e.c.	324	48,360	255	59,267	208	55,300
336	Total industrial machinery and equipment	582	92,302	498	115,452	386	103,589
33	Total other machinery and equipment	1,876	613,483	1,683	856,299	1,373	969,871
345	Leather and leather products	8	1,151	10	1,119	10	652
346	Rubber products	26	2,047	22	2,823	24	5,449
347	Plastic and related products	114	18,122	127	22,215	121	26,079
348	Other manufacturing	48	5,814	65	13,210	78	18,866
34	Total miscellaneous manufacturing	186	27,133	211	39,367	213	51,045
C	**Total manufacturing**	**2,860**	**1,141,716**	**2,780**	**1,579,694**	**2,364**	**1,757,807**
	Other industries —						
16	Services to mining	21	7,603	45	9,623	58	17,267
D-L	Other n.e.c.	196	54,620	254	87,742	277	111,784
16,D-L	**Total other industries**	**215**	**62,223**	**291**	**97,365**	**322**	**129,051**
	TOTAL ALL INDUSTRIES	**3,029**	**1,280,066**	**3,047**	**1,784,430**	**2,653**	**2,017,411**
	Private Sector Contribution	2,968	1,156,550	2,990	1,635,213	2,602	1,813,202
	Public Sector Contribution	61	123,517	57	149,217	51	204,209

(a) The industry of product (or process) field towards which the R & D activity was directed. For further explanation see paragraph 24 of the Explanatory Notes. (b) Excludes enterprises in ASIC Division 'A' (c) Where the R & D performed by an enterprise was directed towards more than one product, that enterprise is counted in each of the industries to which its products are coded. Therefore, the enterprise counts shown in this table cannot be summed to aggregates for combinations of industries.

Business size comparison—

Expenditure

The largest enterprises, employing 1000 or more, account for 37 per cent of total R&D expenditure. On average this is nearly $5m per business undertaking R&D. Businesses employing less than 10 people account for only 5 per cent of the R&D. This averages out at about $100,000 for each business undertaking R&D. The major industries in which these small business undertake research are the Appliances and electrical equipment and the Property and business services industries.

BUSINESS SIZE COMPARISON

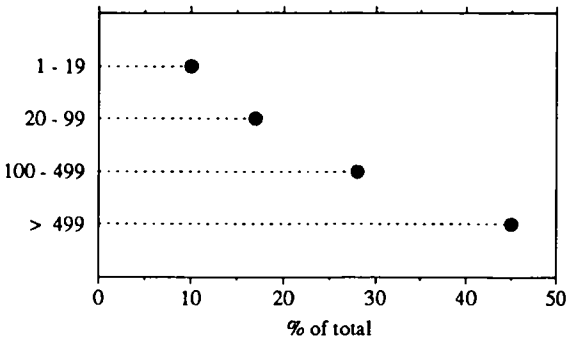


TABLE 8. R&D EXPENDITURE BY BUSINESS ENTERPRISES(a), AUSTRALIA, 1990-91, BY SIZE OF BUSINESS(b) ($'000)

Industry of enterprise ASIC Code	Description	Total	*Enterprise employment size (persons)* Less than 10	10 to 19	20 to 49	50 to 99	100 to 199	200 to 499	500 to 999	1000 or more
11-15	**Mining (excluding services to mining)**	**77,282**	n.p.	n.p.	n.p.	n.p.	—	**4,195**	**5,576**	**59,803**
	Manufacturing —									
21	Food, beverages and tobacco	85,252	314	779	1,137	5,212	8,427	8,368	13,223	47,792
23-24	Textiles, clothing and footwear	7,469	n.p.	—	991	1,236	910	619	2,213	n.p.
25	Wood, wood products and furniture	7,295	n.p.	n.p.	774	1,618	1,283	n.p.	n.p.	n.p.
26	Paper, paper products, printing and publishing	35,441	176	n.p.	n.p.	n.p.	654	1,038	n.p.	22,180
27	Chemical, petroleum and coal products	178,739	2,850	6,896	18,590	9,451	12,632	54,373	37,693	36,253
28	Non-metallic mineral products	17,510	1,399	n.p.	n.p.	n.p.	535	753	4,293	3,411
29	Basic metal products	130,529	627	288	n.p.	904	n.p.	n.p.	6,012	43,420
31	Fabricated metal products	32,646	2,422	1,617	5,046	6,446	3,702	8,022	2,862	2,529
32	Transport equipment	154,994	2,007	1,603	3,474	1,406	5,964	15,067	15,841	109,632
334	Photographic, professional and scientific equipment	41,910	3,970	2,161	1,510	2,850	n.p.	n.p.	—	n.p.
335	Appliances and electrical equipment	275,105	30,055	30,618	49,692	25,139	20,903	17,005	23,520	78,172
336	Industrial machinery and equipment	60,261	8,881	4,419	8,460	10,564	8,607	8,400	5,163	5,767
34	Miscellaneous manufacturing	32,883	2,406	4,898	3,033	5,492	2,587	2,816	7,961	3,690
C	**Total manufacturing**	**1,060,033**	**56,514**	**56,652**	**112,474**	**77,014**	**90,507**	**177,812**	**126,945**	**362,115**
	Other industries —									
F	Wholesale and retail trade	174,160	5,589	8,348	10,794	27,806	30,813	71,804	13,367	5,640
61-62	Finance	124,012	1,388	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.	110,881
63	Property and business services	249,007	25,835	15,482	29,856	20,570	50,847	47,400	5,126	53,891
8461	Research and scientific institutions	111,161	n.p.	11,063	17,670	23,056	51,394	n.p.	—	—
(c)	Other n.e.c.	221,756	n.p.	4,588	9,295	2,895	n.p.	43,378	n.p.	148,196
16, D-L	**Total other industries**	**880,096**	n.p.	n.p.	n.p.	n.p.	**134,815**	**164,688**	**29,658**	**318,607**
	TOTAL ALL INDUSTRIES	**2,017,411**	**102,693**	**103,115**	**181,535**	**155,347**	**225,322**	**346,694**	**162,179**	**740,525**
	Private sector contribution to 'Total all industries' —									
	1990-91	1,813,202	n.p.	103,115	n.p.	152,960	224,512	308,523	155,415	585,073
	1988-89r	1,635,213	106,056	88,959	179,030	138,354	194,500	230,860	161,385	536,071

(a) Excludes enterprises in ASIC Division 'A' (b) Employment size is based on the number of persons employed by the enterprise. (c) ASIC Codes 16,D,E,G,H,J,8141-8306,8462-8495,L.

Employment

For those businesses undertaking R&D, those employing 1000 or more contribute 36 per cent of the human resource effort. However less than 1 per cent of their total employment is devoted to R&D. On the other hand the smallest size category (less than 10 employees) devote over 30 per cent of their effort to research, but this contributes only 7 per cent of the total human resources undertaking R&D.

TABLE 9. HUMAN RESOURCES DEVOTED TO R&D BY BUSINESS ENTERPRISES, AUSTRALIA(a), 1990-91, BY SIZE OF BUSINESS(b)
(person years)

Industry of enterprise ASIC Code	*Description*	*Total*	*Enterprise employment size (persons)* Less than 10	10 to 19	20 to 49	50 to 99	100 to 199	200 to 499	500 to 999	1000 or more
11-15	**Mining (excluding services to mining)**	559	1	n.p.	n.p.	19	—	25	32	n.p.
	Manufacturing —									
21	Food, beverages and tobacco	925	4	8	13	72	59	91	129	550
23-24	Textiles, clothing and footwear	74	n.p.	—	13	9	10	7	26	n.p.
25	Wood, wood products and furniture	107	n.p.	n.p.	10	30	20	n.p.	n.p.	n.p.
26	Paper, paper products, printing and publishing	231	3	n.p.	n.p.	n.p.	8	10	n.p.	178
27	Chemical, petroleum and coal products	1,799	41	66	184	144	174	567	287	337
28	Non-metallic mineral products	159	14	n.p.	n.p.	n.p.	8	n.p.	56	39
29	Basic metal products	969	6	2	14	15	n.p.	n.p.	48	425
31	Fabricated metal products	354	39	23	37	58	58	65	36	37
32	Transport equipment	1,463	33	28	34	25	29	206	169	940
334	Photographic, professional and scientific equipment	490	58	31	22	38	69	n.p.	—	n.p.
335	Appliances and electrical equipment	3,605	461	405	692	382	233	190	283	959
336	Industrial machinery and equipment	710	84	n.p.	115	133	86	106	65	n.p.
34	Miscellaneous manufacturing	375	21	39	38	58	n.p.	41	n.p.	44
C	**Total manufacturing**	**11,258**	**771**	**672**	**1,178**	**990**	**974**	**1,794**	**1,216**	**3,664**
	Other industries —									
F	Wholesale and retail trade	1,629	74	99	n.p.	291	280	540	115	n.p.
61-62	Finance	1,271	18	17	13	n.p.	n.p.	n.p.	n.p.	1,145
63	Property and business services	2,490	334	221	375	215	438	414	66	428
8461	Research and scientific institutions	986	93	n.p.	174	216	451	n.p.	—	—
(c)	Other n.e.c.	1,791	45	n.p.	59	n.p.	n.p.	240	n.p.	1,306
16, D-L	**Total other industries**	**8,168**	**564**	**n.p.**	**n.p.**	**768**	**1,185**	**1,203**	**292**	**n.p.**
	TOTAL ALL INDUSTRIES	**19,985**	**1,336**	**1,103**	**1,950**	**1,777**	**2,159**	**3,022**	**1,540**	**7,098**
	Private sector contribution to 'Total all industries' —									
	1990-91	18,103	1,334	n.p.	n.p.	1,738	2,147	2,826	1,473	5,540
	1988-89r	18,858	1,527	1,219	2,105	1,800	2,068	2,480	1,915	5,745

(a) Excludes enterprises in ASIC Division 'A' (b) Employment size is based on the number of persons employed by the enterprise, whereas human resources data are person years of R & D effort (c) ASIC Codes 16,D,E,G,H,J,8141-8306,8462-8495,L.

Type of R&D staff

While total human resources devoted to R&D in 1990-91 decreased by 2 per cent over 1988-89, researchers increased by 1%. This increase has occurred mainly in the Appliances and electrical equipment (12%) and Chemicals petroleum and coal products (7%) industries within the manufacturing sector.

Technicians increased over 1988-89 by 35 per cent in the mining sector but recorded decreases in the other sectors. The most significant of these decreases was 34 per cent in Transport equipment manufacturing and 17 per cent in the Property and business services industries.

Other staff decreased 66 per cent from 1988-89 in the mining and 5% in the manufacturing sectors and recorded a 2% rise in total other industries.

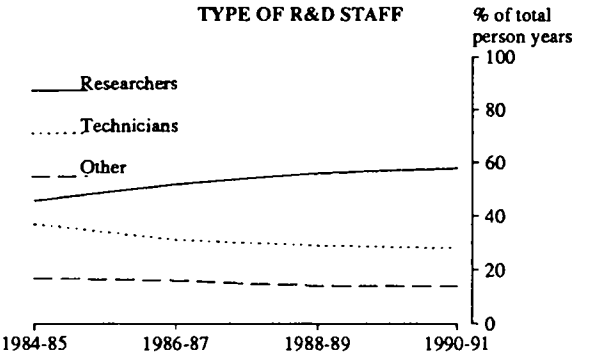


TABLE 10. HUMAN RESOURCES DEVOTED TO R&D BY BUSINESS ENTERPRISES, AUSTRALIA(a), 1990-91, BY TYPE OF EMPLOYEE
(person-years)

Industry of enterprise ASIC Code	Description	Total	*Type of employee* Researchers	Technicians	Other supporting staff
11-15	**Mining (excluding services to mining)**	**559**	**160**	**359**	**40**
	Manufacturing —				
21	Food, beverages and tobacco	925	525	236	164
23-24	Textiles, clothing and footwear	74	36	26	11
25	Wood, wood products and furniture	107	46	34	26
26	Paper, paper products, printing and publishing	231	94	77	60
27	Chemical, petroleum and coal products	1,799	1,017	543	238
28	Non-metallic mineral products	159	89	47	23
29	Basic metal products	969	522	263	184
31	Fabricated metal products	354	149	127	78
32	Transport equipment	1,463	697	502	264
334	Photographic, professional and scientific equipment	490	327	118	44
335	Appliances and electrical equipment	3,605	2,506	758	341
336	Industrial machinery and equipment	710	350	218	143
34	Miscellaneous manufacturing	375	196	113	66
C	**Total manufacturing**	**11,258**	**6,554**	**3,062**	**1,643**
	Other industries —				
F	Wholesale and retail trade	1,629	1,212	264	153
61-62	Finance	1,271	758	437	77
63	Property and business services	2,490	1,464	644	382
8461	Research and scientific institutions	986	564	254	169
(b)	Other n.e.c.	1,791	963	521	307
16, D-L	**Total other industries**	**8,168**	**4,962**	**2,119**	**1,087**
	TOTAL ALL INDUSTRIES	**19,985**	**11,675**	**5,540**	**2,770**
	Private sector contribution to 'Total all industries' —				
	1990-91	18,103	10,494	5,092	2,517
	1988-89r	18,858	10,612	5,611	2,635

(a) Excludes enterprises in ASIC Division 'A' (b) ASIC codes 16,D,E,G,H,J,8141-8306,8462-8495,L.

Extramural R&D

Extramural R&D expenditure (payments to other organisations to undertake R&D projects) is estimated to be $256m, an increase of 22 per cent over 1988-89 which continues the growth exhibited over the previous few years. There were however less businesses making these payments in 1990-91 compared to 1988-89. The Wholesale and retail trade and Chemical, petroleum and coal products industries are the leading industries making extramural payments at $41m and $35m respectively.

Extramural payments are equivalent to 13 per cent of BERD, up from 12 per cent in both 1986-87 and 1988-89.

EXTRAMURAL R&D

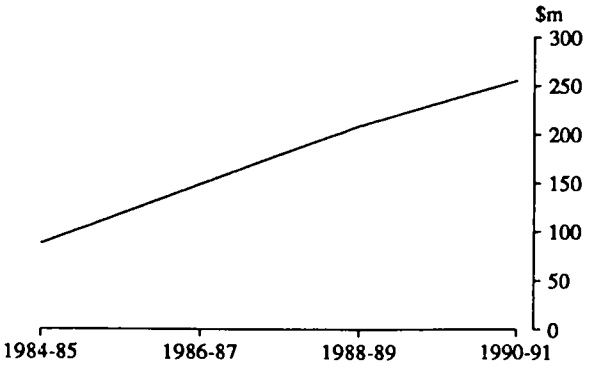


TABLE 11. EXTRAMURAL R&D EXPENDITURE(a) BY BUSINESS ENTERPRISES(b), AUSTRALIA

Industry of enterprise making payment ASIC Code	*Description*	*1986-87r* Enterprises (number)	*1986-87r* Payments ($'000)	*1988-89r* Enterprises (number)	*1988-89r* Payments ($'000)	*1990-91* Enterprises (number)	*1990-91* Payments ($'000)
11-15	**Mining (excluding services to mining)**	**32**	**7,572**	**43**	**13,311**	**46**	**28,657**
	Manufacturing —						
21	Food, beverages and tobacco	46	5,772	51	8,343	45	19,385
23-24	Textiles, clothing and footwear	6	n.p.	9	506	4	685
25	Wood, wood products and furniture	13	450	15	918	10	625
26	Paper, paper products, printing and publishing	11	774	8	1,211	5	n.p.
27	Chemical, petroleum and coal products	63	24,116	75	28,711	69	35,091
28	Non-metallic mineral products	11	n.p.	12	920	19	2,387
29	Basic metal products	16	7,240	22	5,178	18	16,055
31	Fabricated metal products	21	1,065	20	1,230	16	1,040
32	Transport equipment	11	1,531	18	7,084	15	3,349
334	Photographic, professional and scientific equipment	13	800	18	2,310	11	n.p.
335	Appliances and electrical equipment	63	7,083	63	16,460	64	22,675
336	Industrial machinery and equipment	27	1,463	30	1,675	23	893
34	Miscellaneous manufacturing	22	768	18	5,790	18	8,043
C	**Total manufacturing**	**323**	**53,042**	**359**	**80,334**	**317**	**111,830**
	Other industries —						
F	Wholesale and retail trade	64	28,194	79	38,712	62	41,091
61-62	Finance	19	9,558	19	8,029	9	1,366
63	Property and business services	70	22,277	81	14,716	56	18,763
8461	Research and scientific institutions	23	9,731	33	33,817	22	25,023
(c)	Other n.e.c.	60	18,713	64	19,988	65	28,929
16, D-L	**Total other industries**	**236**	**88,473**	**276**	**115,262**	**214**	**115,171**
	TOTAL ALL INDUSTRIES	**591**	**149,087**	**678**	**208,907**	**577**	**255,658**
	Private Sector Contribution	555	126,357	637	194,119	548	232,928
	Public Sector Contribution	36	22,731	41	14,788	29	22,731

(a) Expenditure on R & D which is funded by an enterprise but carried out by other enterprises. (b) Excludes enterprises in ASIC Division 'A'. (c) ASIC codes 16,D,E,G,H,J,8141-8306,8462-8495,L.

Payments and receipts for technical know-how

Payments for technical know-how are estimated to be $354m while receipts are estimated to be $281m. These payments are equivalent to 18 per cent and 14 per cent of BERD, down from 21 per cent and up from 7 per cent respectively in 1986-87.

The Chemical, petroleum and coal products industry remains the leading industry making payments for technical know-how at $77m followed by Transport equipment at $59m and Appliances and electrical equipment at $36m.

Property and business services is the leading industry earning receipts for technical know-how at $108m.

PAYMENTS AND RECEIPTS FOR TECHNICAL KNOW-HOW

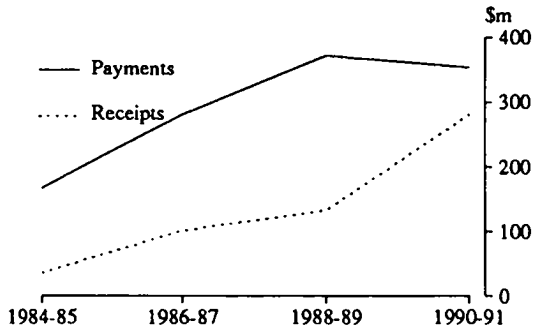


TABLE 12. PAYMENTS AND RECEIPTS FOR TECHNICAL KNOW-HOW BY BUSINESS ENTERPRISES(a), AUSTRALIA ($m)

Industry of enterprise ASIC Code	*Description*	*Payments for technical know-how* 1986-87r	1988-89r	1990-91	*Receipts for technical know-how* 1986-87r	1988-89r	1990-91
11-15	**Mining (excluding services to mining)**	**0.1**	n.p.	**0.6**	n.p.	n.p.	n.p.
	Manufacturing —						
21	Food, beverages and tobacco	23.6	26.6	34.6	2.8	2.6	0.6
23-24	Textiles, clothing and footwear	n.p.	4.1	3.3	n.p.	n.p.	n.p.
25	Wood, wood products and furniture	0.2	1.6	0.8	0.6	n.p.	n.p.
26	Paper, paper products, printing and publishing	4.0	8.7	9.9	n.p.	n.p.	0.4
27	Chemical, petroleum and coal products	53.3	68.2	76.5	6.2	2.1	2.1
28	Non-metallic mineral products	1.8	7.8	7.9	n.p.	1.0	n.p.
29	Basic metal products	9.8	23.8	n.p.	n.p.	2.6	n.p.
31	Fabricated metal products	3.9	8.5	1.4	1.2	1.1	1.4
32	Transport equipment	35.5	57.9	59.3	1.0	3.9	9.3
334	Photographic, professional and scientific equipment	n.p.	3.1	n.p.	n.p.	n.p.	n.p.
335	Appliances and electrical equipment	48.4	34.8	35.6	3.8	15.9	37.2
336	Industrial machinery and equipment	12.2	12.7	8.9	n.p.	8.8	12.0
34	Miscellaneous manufacturing	11.0	25.4	12.0	n.p.	3.1	1.0
C	**Total manufacturing**	**240.0**	**283.5**	**279.6**	n.p.	n.p.	n.p.
	Other industries —						
F	Wholesale and retail trade	11.3	24.8	28.1	4.2	6.4	26.3
61-62	Finance	n.p.	n.p.	10.4	0.1	0.9	n.p.
63	Property and business services	7.7	11.2	10.5	37.0	62.2	107.6
8461	Research and scientific institutions	n.p.	n.p.	n.p.	3.0	13.5	14.0
(b)	Other n.e.c.	8.6	10.8	n.p.	6.0	7.1	n.p.
16, D-L	**Total other industries**	**41.0**	n.p.	**73.8**	**50.4**	**90.2**	**205.3**
	TOTAL ALL INDUSTRIES	**281.0**	**373.0**	**354.0**	**101.6**	**133.2**	**281.1**
	Private Sector Contribution	280.3	372.1	352.7	101.6	132.8	n.p.
	Public Sector Contribution	0.8	0.8	1.3	—	0.4	n.p.

(a) Excludes enterprises in ASIC Division 'A' (b) ASIC codes 16,D,E,G,H,J,8141-8306,8462-8495,L.

Patent activity

Businesses with R&D activity during 1990-91 lodged 1,641 patent applications within Australia, and 2,677 abroad during the period 1 July 1989 to 30 June 1991. During this period 931 patents were granted in Australia, and 1,597 granted abroad. These numbers were generally down when compared with the equivalent period between 1987 to 1989.

TABLE 13. PATENT ACTIVITY BY BUSINESS ENTERPRISES(a) UNDERTAKING R&D DURING 1990-91

Industry of enterprise ASIC Code	Description	July 1987 - June 1989r				July 1989 - June 1991			
		Australia		Overseas		Australia		Overseas	
		Patents lodged	Patents granted	Patents lodged	Patents granted	Patents lodged	Patents granted	Patents lodged	Patents granted
11-15	**Mining (excluding services to mining)**	**8**	n.p.	n.p.	n.p.	**8**	n.p.	n.p.	n.p.
	Manufacturing —								
21	Food, beverages and tobacco	14	5	56	n.p.	22	17	22	23
23-24	Textiles, clothing and footwear	21	21	33	39	31	25	15	14
25	Wood, wood products and furniture	29	21	14	12	18	9	89	20
26	Paper, paper products, printing and publishing	22	11	n.p.	n.p.	26	13	13	n.p.
27	Chemical, petroleum and coal products	99	52	206	120	121	77	232	280
28	Non-metallic mineral products	23	10	n.p.	7	13	5	10	n.p.
29	Basic metal products	90	37	153	57	91	44	252	93
31	Fabricated metal products	165	87	163	145	186	120	154	95
32	Transport equipment	72	41	143	55	90	51	34	35
334	Photographic, professional and scientific equipment	61	22	249	49	87	16	89	25
335	Appliances and electrical equipment	318	143	593	256	223	130	305	198
336	Industrial machinery and equipment	221	124	316	207	160	84	196	182
34	Miscellaneous manufacturing	143	42	179	57	129	81	110	87
C	**Total manufacturing**	**1,278**	**616**	**2,238**	**1,048**	**1,197**	**672**	**1,521**	**1,064**
	Other industries —								
F	Wholesale and retail trade	129	63	169	64	105	52	114	69
61-62	Finance	7	n.p.	n.p.	n.p.	15	n.p.	n.p.	n.p.
63	Property and business services	193	113	381	210	150	93	306	313
8461	Research and scientific institutions	108	65	528	297	80	60	597	97
(b)	Other n.e.c.	112	38	159	36	86	42	132	42
16, D-L	**Total other industries**	**549**	n.p.	n.p.	n.p.	**436**	n.p.	n.p.	n.p.
	TOTAL ALL INDUSTRIES	**1,835**	**906**	**3,549**	**1,681**	**1,641**	**931**	**2,677**	**1,597**
	Private Sector Contribution	1,817	901	3,504	1,665	1,605	921	2,636	1,592
	Public Sector Contribution	18	5	45	16	36	10	41	5

(a) Excludes enterprises in ASIC Division 'A'. (b) ASIC Codes 16,D,E,G,H,J,8141-8306,8462-8495,L.

Energy R&D

R&D devoted towards the producing, storing, transmitting, utilising and conserving of energy carried out in Australia in 1990-91 by the Business sector is estimated to be $115m, an increase of 11% from that in 1988-89. This level of expenditure is equivalent to 6 per cent of total R&D and is at the same level as in 1988-89.

Industry sources continue to be the main source of funds for energy R&D, remaining stable at 88 per cent. Property and business services and Other industries n.e.c. remain the two main industries conducting energy R&D.

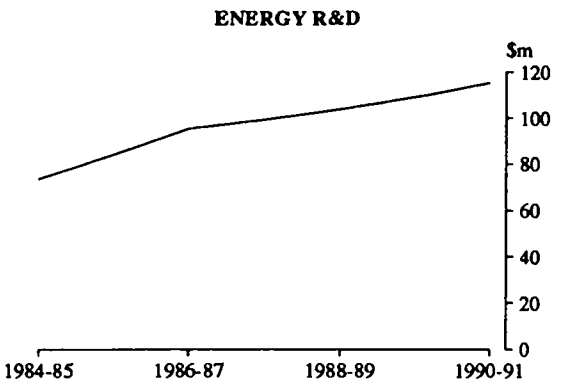


TABLE 14. ENERGY R&D BY BUSINESS ENTERPRISES(a), AUSTRALIA
($'000)

Industry of enterprise ASIC Code	*Description*	*1988-89r* Total Expenditure	*1988-89r* Source of funds: Industry(b)	*1988-89r* Source of funds: Gov't(c)	*1990-91* Total Expenditure	*1990-91* Source of funds: Industry(b)	*1990-91* Source of funds: Gov't(c)
11-15	**Mining (excluding services to mining)**	**15,336**	**14,462**	**874**	**9,419**	n.p.	n.p.
	Manufacturing —						
21	Food, beverages and tobacco	120	120	—	n.p.	n.p.	—
23-24	Textiles, clothing and footwear	341	n.p.	n.p.	n.p.	n.p.	—
25	Wood, wood products and furniture	n.p.	n.p.	—	n.p.	n.p.	—
26	Paper, paper products, printing and publishing	n.p.	—	n.p.	n.p.	n.p.	—
27	Chemical, petroleum and coal products	771	n.p.	n.p.	805	805	—
28	Non-metallic mineral products	246	246	—	509	509	—
29	Basic metal products	n.p.	n.p.	n.p.	6,371	n.p.	n.p.
31	Fabricated metal products	1,162	1,162	—	288	288	—
32	Transport equipment	445	445	—	1,550	n.p.	n.p.
334	Photographic, professional and scientific equipment	n.p.	n.p.	—	n.p.	n.p.	—
335	Appliances and electrical equipment	8,060	7,518	542	9,974	8,896	1,078
336	Industrial machinery and equipment	2,716	2,526	190	1,820	n.p.	n.p.
34	Miscellaneous manufacturing	973	n.p.	n.p.	319	n.p.	n.p.
C	**Total manufacturing**	**21,580**	**19,254**	**2,326**	**23,574**	**20,813**	**2,761**
	Other industries —						
F	Wholesale and retail trade	1,647	n.p.	n.p.	3,170	2,613	557
61-62	Finance	n.p.	n.p.	n.p.	n.p.	n.p.	—
63	Property and business services	22,381	19,848	2,532	37,462	33,659	3,802
8461	Research and scientific institutions	n.p.	n.p.	n.p.	n.p.	n.p.	n.p.
(d)	Other n.e.c.	29,048	27,274	1,774	27,927	25,775	2,152
16, D-L	**Total other industries**	**67,214**	**58,065**	**9,149**	**82,339**	n.p.	n.p.
	TOTAL ALL INDUSTRIES	**104,130**	**91,781**	**12,350**	**115,332**	**101,683**	**13,649**
	Private Sector Contribution	83,440	72,652	10,789	94,103	82,167	11,936
	Public Sector Contribution	20,690	19,129	1,561	21,229	19,516	1,713

(a) Excludes enterprises in ASIC Division 'A' (b) Includes private and public business enterprises and private non-profit organisations. (c) Includes Commonwealth and State Government organisations, universities and colleges of advanced education (d) ASIC Codes 16,D,E,G,H,J,8141-8306,8462-8495,L.

EXPLANATORY NOTES

Introduction

This publication presents statistics on expenditure and human resources devoted to R & D carried out in Australia by enterprises within the Business Enterprise sector during 1990-91.

2. Statistics also included are R&D directed towards: extramural R&D activity; payments and receipts for technical know-how; patent activity, and energy R&D.

3. Comparable R&D statistics are produced for the General Government, Private Non-Profit and Higher Education sectors (see paragraph 29).

Data sources

4. The 1990-91 data presented in this publication have been compiled from data collected from business enterprises in the Survey of Research and Experimental Development in respect of the year ended June 1990. This survey was based on a complete enumeration of businesses identified by the Australian Bureau of Statistics (ABS) as *likely R&D performers*. The survey was conducted by mailed questionnaires and a 90% response was obtained. Non-respondents were assumed to be non-R&D performers.

5. The 1984-85, 1986-87 and 1988-89 statistics in this publication were derived from similar surveys. The 1985-86, 1987-88 and 1989-90 statistics were derived from a stratified random sample of businesses identified as likely R&D performers. A number of revisions have been made to previous statistics.

6. Limited additional detailed R&D statistics will be available at a charge from the ABS when compiled. Revised details for previous R&D Surveys are also available at a charge.

7. The GDP figures used to derive BERD/GDP ratios quoted in the Summary of Findings are current at time of manuscript finalisation *National Income and Expenditure, December Quarter 1991* (5206.0) and are as follows: $216,150m (1984-85); $240,319m (1985-86); $264,564m (1986-87); $298,335m (1987-88); $340,440m (1988-89) $370,805m (1989-90) and, $377,114m (1990-91). For further information please see *Australian National Accounts, National Income and Expenditure, 1990-91* (5204.0). The available BERD/GDP ratios for other OECD countries are current at time of manuscript finalisation and are sourced from *Main Science and Technology Indicators, 1991*, OECD, Paris, 1991.

Definitions

8. Research and Experimental Development is defined in accordance with the Organisation for Economic Co-operation and Development (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'.

9. The definition of R&D was extended for the 1984-85 survey, in accordance with a change in OECD standards, to include research into and development (or substantial modification) of computer software such as applications software, new programming languages and new operating systems.

10. For more comprehensive interpretation of the definition of R&D activity, contact the ABS or refer to the OECD publication, *The Measurement of Scientific and Technical Activities* ("Frascati Manual" 1980) OECD, Paris 1981.

11. Type of R&D activity comprises 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. 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.

Scope

12. The scope of this survey is all enterprises within the Business Enterprise Sector of Australia.

13. The Business Enterprise sector includes all enterprises 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.

14. Prior to the 1988-89 survey the organisational unit for the collection of R&D statistics had been the enterprise. An enterprise is defined broadly as the unit comprising all the operations in Australia of a single operating legal entity (e.g. company, partnership or sole proprietor).

15. From the beginning of 1989, the ABS has introduced a new statistical unit known as the management unit. This unit is defined as:

> the largest unit within a business for which separate accounts are maintained; in nearly all cases this coincides with the legal entity owning the business (ie company, partnership, trust, sole proprietor, etc). In the case of large diversified businesses there may be more than one management unit, each coinciding with a 'division' or 'line of business'. A division or line of business is recognised where separate and comprehensive accounts are compiled for it.

16. The management unit is being implemented on the ABS central register of economic units and included in surveys when reporting arrangements with the larger enterprises are finalised. Where the management unit has not been implemented the statistical unit is still the enterprise as presently recorded on the ABS central register of economic units.

Coverage

17. The vast majority of enterprises in this sector are private businesses. The remainder are public business enterprises mainly engaged in trading or financial activities.

18. The 1990-91 R&D survey comprised a complete enumeration of business enterprises identified by the ABS as likely to have:

(a) carried out R&D activity; or

(b) funded R&D activity to be carried out by other enterprises, institutions or individuals.

19. The business enterprise sector for the R&D survey excludes enterprises mainly engaged in agriculture, forestry, fishing and hunting (i.e. industries in Division A of the Australian Standard Industrial Classification (ASIC), 1983 edition), partly because of collection difficulties and partly because such enterprises are believed to have very low R&D activity (agricultural R&D activity is generally carried out by specialised research institutes not included in ASIC Division A).

20. Within the scope of the survey, enterprises were included in the collection if they satisfied any of the following criteria:

(a) Enterprises which, in previous R&D surveys, reported R&D activity, payments or receipts for technical know-how, or patent activity.

(b) Units applying for the 150 per cent Tax Concession Scheme and the Grants for Industry R&D Scheme.

(c) Enterprises identified from reports in newspapers, industrial journals, research compendia etc. as likely to have R&D activity.

21. The ABS continues to investigate enhancement of the above criteria, or the introduction of additional criteria, with the aim of further improving the coverage of the R&D survey. In the past this coverage has been calculated as accounting for very high percentages, usually in the high nineties, of R&D activity.

Australian Standard Industrial Classification (ASIC)

22. The Statistics in this publication are classified by the industry of enterprise in accordance with the 1983 edition of the ASIC.

23. Each enterprise is classified by the ABS to the industry in which it mainly operates even though one or more of its component establishments (factories, shops, etc.) may be classified to other industries. For further comment see the *Australian Standard Industrial Classification, 1983, Volume 1* (1201.0).

24. Business enterprise sector R&D expenditure presented in Table 7 are classified by the industry of the product/process field towards which the R&D activity was directed. This involved asking each business to apportion its total R&D expenditure towards the products/processes to which it was directed. For example, an enterprise classified as being in mining may have performed R&D activity into a more efficient ore crusher. As the manufacture of ore crushers would be classified to ASIC Class 3369 then this R&D expenditure would be classified to class 3369.

Constant price estimates

25. Estimates of total R&D expenditure are shown at average 1984-85 prices in Table 1. In concept, constant price estimates are measures from which direct effects of price change have been eliminated. Although expressed in monetary terms, the constant price measures shown vary only with changes in the underlying quantities of inputs purchased (including labour). In effect, quantities of broadly defined categories of inputs are weighted by their prices in the base year (1984-85). Because the measures relate to input quantities, they do not reflect changes in the efficiency with which labour, capital and other inputs are used.

26. The estimate of the labour costs component was obtained by multiplying each broad category of labour used in each period by the relevant average labour costs in the base year (1984-85). The non-labour costs components were estimated by deflating each by a composite price index of relevant materials or capital expenditure items. In revaluing R&D non-labour expenditure, extensive use has been made of price series used in deriving constant price national accounts estimates.

27. For a more comprehensive description of constant price concepts and estimation procedures see *Australian National Accounts: Concepts, Sources and Methods* (5216.0).

Reliability of statistics

28. The statistics in this publication must be interpreted with caution for the following reasons:

(a) Many respondents had to make estimates because their accounts do not separately record data on R&D activity, receipts and payments for technical know-how or patent activity.

(b) The OECD standard definition of R&D used for 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, and the 150 per cent Tax Concession Scheme for tax deductability for specific R&D activities undertaken within Australia, differ slightly.

Related publications

29. Users may also wish to refer to the following publications:

Research and Experimental Development, General Government and Private Non-Profit Organisations, Australia, 1990-91 (8109.0) (to be released shortly)

Research and Experimental Development, Higher Education Organisations, Australia, 1990 (8111.0) (to be released shortly)

Research and Experimental Development, All Sector Summary, Australia, 1990-91 (8112.0) (to be released shortly)

Research and Experimental Development, Business Enterprises (Inter Year Survey), Australia, 1989-90 (8114.0)

Measures of Science and Innovation, Australian Science and Technology Indicators Report, Department of Industry, Technology and Commerce, Canberra, Australia, 1987

Main S & T Indicators 1991, OECD, Paris, 1991

The Measurement of Scientific and Technical Activities ("Frascati Manual" 1980) OECD, Paris, 1981

30. Current publications issued by the ABS are listed in the *Catalogue of Publications and Products, Australia* (1101.0). The ABS also issues, on Tuesdays and Fridays, a *Publications Advice* (1105.0) which lists publications to be released in the next few days. The Catalogue and Publications advice are available from any ABS office.

Symbols and other usages

n.e.c.	not elsewhere classified
n.p.	not available for separate publication (but included in totals where applicable)
n.a.	not available
—	nil or rounded to zero
r	revised since previous issue

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

GLOSSARY

Applied research is 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 is 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 necessary for the solution of recognised practical problems.

BERD — Business expenditure on R&D is the sum of all intramural R&D expenditures incurred by all organisations in the survey.

Capital expenditure is expenditure on the acquisition (less disposals) of fixed tangible assets such as land, buildings, vehicles, plant, machinery and equipment attributable to R&D activity.

Current expenditure is expenditure on labour costs, materials, fuels, rent and leasing, repairs and maintenance, data processing etc. and the proportion of expenditure on general services and overheads which is attributable to R&D activity.

Energy R&D statistics refer to R&D activity directed towards the producing, storing, transmitting, utilising and conserving of energy.

Experimental development is systematic work, using existing knowledge gained from research or practical experience for the purpose of creating new or improved products/processes.

Extramural R&D statistics refer to R&D activity *funded* by an organisation but *carried out by other* enterprises, organisations, institutions or individuals.

GIRD — Grants for Industry R&D Scheme.

Human resources devoted to R&D measures 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.*

Intramural R&D activity is R&D carried out by an organisation on its own behalf or on behalf of other organisations, institutions or individuals.

Other supporting staff are those skilled and unskilled craftspersons, secretarial and clerical staff directly associated with R&D activity.

R&D activity in the business context is 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 are those involved with the conception and/or development of new products/processes e.g. executives and directors involved in the planning or management of scientific and technical aspects of R&D projects, and software developers / programmers. They exclude executives and directors concerned primarily with budgets and human resources rather than project content.

Technical know-how (TKH) is the 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 enterprise. Payments are those made directly to the holders of TKH which is new to a business enterprise. They exclude non-monetary transfers, and costs incurred by an enterprise in obtaining TKH, such as overseas travel costs.

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

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

UNPUBLISHED DATA
BUSINESS ENTERPRISES

A range of additional tables are available from the list set out below for a standard cost of $20.00 per table.

Further related statistics are available on request subject to conditions of data availability.

Contact John Ovington, Science and Technology Sub-section on Canberra (06) 252 5627 for more information.

A. Intramural research and experimental development (R&D) activity: R&D carried out by business enterprises

R&D expenditure by detailed industry of enterprise:

- by type of expenditure,type of activity and enterprise employment size
- industry of enterprise by R&D expenditure size
- R&D expenditure size
- industry of product field, 1988-89 and 1990-91
- industry of product by enterprise employment size

Human resources devoted to R&D by detailed industry of enterprise :

- by type of employee and enterprise broad employment size
- a percentage of enterprise employment by industry of enterprise by enterprise employment size

B. Extramural R&D expenditure: Expenditure by business enterprises on R&D carried out by others

Payments by:

- industry of enterprise making payment by location of recipient
- country of recipient by relationship of recipient to enterprise making payment, 1988-89 and 1990-91
- Country of recipient
- enterprise employment size

C. Payments and receipts by business enterprises for technical know-how

Payments:

- details by industry of enterprise
- overseas by industry of enterprise
- by country of recipient
- by industry of enterprise by enterprise employment size
- by enterprise employment size

Receipts:

- by country of recipient
- by industry of enterprise by enterprise employment size
- by enterprise employment size

D. Patent activity by business enterprises

Patent activity, July 1989 to June 1991, by industry of enterprise and number of enterprises

Australian Bureau of Statistics

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