Investment in private R & D before 1989: use of proxies

Is it better to travel hopefully than arrive satisfactorily?

By Robin Johnson[1]

Recent analyses of private investment in R&D in NZ, such as that of Weshah Razzak and Julia Hall, have utilised some rough data approximations for the period from 1960 to 1990 before the MoRST survey came into effect. On the public investment side, there are more adequate records of government departmental expenditures and grants going back to the 1960s. This paper reports on a suggestion (made originally by Ralph Lattimore) that the expenditure on R&D by para-statals like the marketing boards would offer some guidance. The relevance of this is that the MoRST survey classifies marketing boards as part of the private sector and not the public sector. Business investment cannot be retrieved retrospectively, unfortunately. The boards supported a series of research institutes (like DRI, MIRINZ, and WRONZ) who were ostensibly part of the processing sector but which also did R&D for primary producers. These institutes also received government grants through the DSIR. In the event, only 3 institutes – WRONZ, DRI and LASRA[2] *– could provide records of research expenditure back to 1960. Hence the title of this paper – the proposal is that the combined expenditure of three of the institutes could provide a proxy for not only all the other institutes but also that of the business sector! This series was then adjusted to the 1989 determinations of MoRST to create a new series of private investment in NZ R&D. This paper discusses these techniques and compares the resulting data with earlier results determined by the author (Johnson 1999).*

Introduction

There have been several recent studies of the role of R&D investment in the economy (Johnson 1999, Johnson 2000a, Johnson, Razzak and Stillman 2006, Hall and Scobie 2006). These studies are dependent on the research data available on business and government expenditure on R&D. Hall and Scobie employ original estimates for the agricultural sector back to 1927. Private investment is proxied by utilising an indicator of government (DSIR) grants to the sector. Since 1989, MoRST (and latterly Statistics New Zealand) have conducted a bi-annual survey of firms and organisations

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[1] Consultant, 59 Allington Road, Wellington**; (***johnsonr1@paradise.net.nz**).* Paper prepared for 2006 meeting of NZ Association of Economists.

[2] Wool Research Organisation of New Zealand, Dairy Research Institute (now Fonterra), and Leather and Shoe Research Association.

to determine annual spending in the private sector, in the government sector, and in the universities. Before 1989 there are fairly good records on government expenditure but very little on the business sector and the universities.

The data sets used by the various authors are dependent on the MoRST (1999 and others) survey and government records available before 1989. For Johnson and Razzak studies, a series of private sector estimates determined by Johnson (1999) are employed. For the universities this involved taking a varying proportion of the annual grant to the universities from government for the years before 1989 and interpolating this data with the MoRST data. For the private sector, the ratio of 1989 private expenditure to GDP was extrapolated back to 1960 in line with government expenditure (Table A1 below). The business sector was renamed the private sector, and government and the universities were combined to define the public sector. Hall and Scobie build on the Scobie and Eveleens' paper (1986), and derive agricultural private R&D expenditure from the DSIR grants to the research associations.

My hypothesis is that the private investment record before 1990 would be more acceptable if it were derived from original data of some sort than derived from some varying proportion of GDP. Talking to Ralph Lattimore in August 2005 I realised that some records could survive from the industry research associations which make up an important proportion of the MoRST definition of `business' R&D. (For some reason, MoRST classified the industry research associations as `business' and the CRIs as `government' while Government heavily subsidised them both). To this end, I contacted six of the remaining industry institutes for their records of research expenditure but was only able to locate records for three – DRI, Leather and WRONZ. The remaining three were MIRINZ, Cawthron and the Fertiliser Association. As a fallback from this line of enquiry I re-investigate the kinds of grants and subsidies available for private sector R&D in the 1960s, 1970s and 1980s.

In this paper, I set out the new estimates of private R&D expenditure, their relation to what I prepared in 1999 (Tables A2, A3, and A4), and some new estimates of the research stock elasticities with respect to total factor productivity (TFP), followed by a section of the research grants given to private entities.. The results for the research associations are generally disappointing but they do suggest further interpretations of the R&D history of NZ are possible and future workers could build on them. The results for the analysis based on government grants are more promising and suggest further areas of work.

Building a New Data Set

With the cooperation of the research associations, I collected the annual R&D current expenditure in financial years in current dollars for the three organisations for the period 1962-1990. This is what they actually spent and does not include capital expenditure. Some of it would have been funded by government subsidy especially in the 1960s and 1970s. I then estimated a national total of private expenditure on the assumption that each year's national figure was proportional to that of the three institutes and joining the MoRST figure for 1989-90 (Table A4). The results show that expenditure was somewhat lower in the 1960s and 1970s with a period of rapid

catch up in the 1980s as compared with the previous estimate[3]. I then computed a new set of stocks of private knowledge and combined these with the existing estimates of public stocks. The stock transformation is shown at the foot of Table A3.

In Johnson (1999) these estimates of R&D stocks were tested in a TFP framework on the assumption that the effects of previous R&D expenditure would be brought out in the Solow residual rather than directly on industry net output. In addition, foreign spillovers were incorporated in the form of Australian R&D expenditure and government education expenditure in NZ and these were explored as a measure of human skills and other factors outside the R&D effects on Solow productivity. The TFP measure was derived from the Philpott data set and capital and labour were weighted by fixed weights based the average shares of income for the period concerned. The estimation equation looked like this:

$$(1)\ TFP_{it} = Const + B_1 PVTR\&DS_{it-1} + B_2 PUBR\&DS_{it-1} + B_3 AUSR\&DS_{t-1} + B_4 EDU_{t-1}$$

where the i's refer to industry categories in the old NZSIC SNA system and *S* shows that the stock of research knowledge is being tested. Education expenditure does not enter as a stock.

Due to the incompleteness of the Yearbook records of Government expenditure on R&D before 1990, Philpott's 21 industry categories were summarised into 9 categories: Agriculture, Fishing , Forestry, Primary Processing, Manufacturing, Building and Construction, Transport and Storage, Energy and Services. The aggregate data was for the Market Economy (MK) that is, TFP was estimated for all the then NZSIC categories excluding Ownership of Dwellings and the Government sector..

In the case of industry equations in the form of (1), separate categories of R&D stocks were identified previously and tested (see Table A5). As this methodology was also very approximate, we now test some alternatives to this procedure as well. We use the agriculture sector as an example in this paper.

There is a fairly complete record, compiled by NRAC, of the grants paid out by government departments to various entities for R&D activities. I assume that this was largely paid to the private sector though cross-departmental grants cannot be ruled out. I propose to re-examine this data, available from 1964-65 fiscal year to 1985-86. From 1985-86 to 1989-90 I extrapolated this series in proportion to DSIR grants (Table A6).

Comparisions and Tests: The Market Sector

Table 1 shows the results for the re-estimation of equation (1) for the market sector as defined by Philpott (1994). The tabulation shows the successive estimates made as the data was assembled and refined up to the present time. The results given in the 1999 conference paper were modified in the same year as a mistake was made in the lag

[3] DRI expenditure increased by 83% in 1987-88, Leather expenditure increased by 14% in 1985-86, MIRINZ expenditure increased by 55% in 1989-90, and WRONZ expenditure increased by 55% in 1987-88. At the time of writing I am not sure what is going on here.

system and were published in Johnson (2000b). Successive re-estimations show the effect of:

(a) the new data for private expenditure from the research association for the same period as previously,
(b) the effect of extending the 1999 R&D data up to 2002,
(c) the effect of extending the new data for private expenditure up to 2002, and
(d) the effect of using the government grant series..

The broad pattern emerges that accumulated stocks of private R&D knowledge are consistently related to the following year's Solow residual. The accumulated stocks of public R&D are negatively related to the following year's TFP. There are reasonably consistent relationships between TFP and Australian R&D stocks, but somewhat negative relationships with the level of vote education. This may be because EDU is a poor indicator of skill levels or changes in the Solow residual are driven from elsewhere.

Table 1: Experiments with the Market Economy TFP

		Elasticities wrt TFP				
Description	Constant	PVT_{t-1}	PUB_{t-1}	AUS_{t-1}	EDU_{t-1}	R^2
1. Conference 1999 1962-98	-1.12	0.34*	-0.35*	0.15**	0.04	0.95
2. 1999 Revision 1962-98	-0.95	0.39*	-0.38*	0.13*	0.02	0.95
3. Res Assns Revision 1962-98	6.17	0.10	-0.07	0.25**	-0.21*	0.89
4. No 2 to 2002	0.96	0.75**	-0.67**	0.04	0.03	0.95
5. No 3 to 2002	7.72	0.25*	-0.12*	0.11**	-0.32**	0.87
6. Cobb Douglas model[1] 1962-98	-0.93	0.57**	-0.59**	0.07	0.03	0.99
7. Grants model 1965-90 1965-02	-1.50	0.56**	-0.40**	0.23**	-0.20*	0.88
8 Cointegrated model[2] 1965-02	-9.17	0.27*	-0.63**	-	-	0.98
9. Indexed model[3] 1965-02	0.001	0.64**	-0.49**	0.22**	-0.14	0.89

** Significant at 1 per cent level
* Significant at 5 per cent level

1 This equation took the form Output=F(L,K,PVTS,PUBS,AUSS,EDU)
2 O/L = (K/L,PVTS/L,PUBS/L,L) with grants data
3 First difference model with grants data.

The new data from the research associations contributes nothing in the period 1962-98 but resurfaces over the longer period 1962-2002. In the period 1962-98, public stocks of R&D are now non-sgnificant but also re-emerge in 1962-02. The Cobb Douglas model confirms the earlier results for 1962-98 for private and public stocks of R&D knowledge. The rates of return on depreciated capital invested in private and public R&D vary from $11.9 to $17 per $ invested in the private case and $-4.8 to $-7 in the public case (Johnson 2000b, pp.10-19). The grants model (7) is an improvement on result (5) when the RA ivestment variable is replaced by a grant variable (Table A6). In this specification there is also a significant association with Australian R&D

investment and a negative relationship to Education spending. For the period 1965-98 the grants model also works well.as compared with (3)

The new data on private investment in R&D by RAs is disappointing. The private investment series based on proportions of national income used from 1999 onwards was possibly picking up systematic fluctuations in national income. This then became reflected in the stock of R&D in a given year. Since the dependent variable, TFP, was set as a function of that stock in the previous year, a very positive relationship emerged. The actual expenditure by the research associations appears to be independent of changes in GDP. It is possible that government grants change as Budget policy changes which could be associated with changes in GDP.

Comparisions and Tests: the Agriculture Sector

The next section is devoted to the way I treated individual sectors of the economy in the 1999 analysis. The Johnson *et al* (2006) paper and the Hall and Scobie paper also used the same data base. It will be recalled that historic data availabilities restricted the analyis to 9 sectors, viz, Agriculture, Fishing, Forestry, Primary Processing, Manufacturing, Energy, Building, Transport, and Services. For the R&D data set, these NZSIC categories were matched by groupings of `output areas' according to the then MoRST definitions. In the case of private investment in R&D the MoRST data only ran from the 1989-90 fiscal year. For the period 1962-90 the sector shares were based on the MoRST 1990 survey (Table A5). (In addition, after the publication of the 1999 results, the sector shares were revised to take in the university shares).

The analysis will proceed in steps in the following order:

(a) the effect of the revised 1999 share allocation 1962-98
(b) the effect of the new definition of PVT 1962-98
(c) the effect of updating the data series to 2002
(d) the effect of spillovers in R&D, and
(e) the effect of the grants variable.

The question of spillovers arises because each industry sector obtains new knowledge from the total body of previous research carried out. It may be that in a statistical snse that a given industry group may show a greater sympathy with national trends than with its own sector trends. In addition, the concept of `own' research for an industry is very hazy and in the MoRST surveys is nominated by the providers. There is more discussion of this problem in the Summary and Conclusions section.

Table 2 shows the effects on the agriculture sector of the revised share allocations between industries shown in Table A5.

Table 2: Experiments with the Agriculture Sector TFP (1) 1962-98

		Change of Shares				
Description	Constant	PVT	PUB	AUST	EDU	R^2
1. Conference 1999	3.31	2.59**	-2.32**	-0.43*	0.77**	0.96
2.1999 Revision	4.87	2.91**	-2.51**	-0.46*	0.60*	0.96
3.2003 share revision	5.50	2.40**	-2.02**	-0.71*	0.76*	0.95

The 1999 estimation gave a very strong indication of positive relationships. The 1999 revision likewise. When the university shares were introduced, the elasticities were smaller for PVT and PUB but stayed the same sign and significance.

Table 3 shows the effect of introducing the RA definition of private stocks. Three things have happened: the new PVT stock has no statistical relationship to agricultural TFP; it also drags the public stock variable out of the analysis, and Australian R&D stocks appear to have a considerable effect on agricultural TFP.

Table 3: Experiments with the Agriculture Sector TFP (2) 1962-98
Change of PVT definition

Description	Constant	PVT	PUB	AUST	EDU	R^2
1. Res Assns Revision old shares	-4.69	-0.07	0.06	0.73*	-0.22	0.86
2. RA's + new shares	-4.87	-0.08	0.06	0.76*	-0.23	0.86

Table 4 shows the effect of enlarging the sample to 1962-2002. Public stocks appear to drop out in the longer period but re-appear when the university shares are included. The new private stocks remain non-significant as before and Australain R&D stocks re-appear as they had previously.

Table 4: Experiments with the Agriculture Sector TFP (3) 1962-02
Change of period

Description	Constant	PVT	PUB	AUST	EDU	R^2
1. 1999 shares 62-02	-0.52	0.56**	-0.29	0.05	0.05	0.90
2. Revised shares 62-02	3.10	0.92**	-0.48**	-0.48	0.25	0.91
3. RA's+old shares 62-02	-3.61	0.10	0.11	0.49**	-0.16	0.88
4. RA's+'03shares 62-02	-0.81	0.22	0.05	0.28	-0.29	0.88

Table 5 shows some results testing the spillover hypothesis. In 1. we test whether national PVT R&D stocks would offer a better explanation of changes in agriculture TFP in place of the supposed agriculture share. The elasticity is greater than earlier results but at a lesser degree of significance. Public stocks in agriculture are non-significant and Australian stocks take their place. In 2. we test whether national public investment is more important than agricultural public investment alongside the research association definition of private agricultural investment. Apparently nothing works in this specification. In 3. we test whether we can replace both private and public agricultural stocks with the respective national stocks. As might perhaps be expected there is no significant association and Australian stocks appear to be dominant.

Table 6 shows the results when the `Grants' definition of private investment is substituted in the estimation. The `Grants' set only starts in 1964-65. No 1. shows that the agricultural share of the grants variable is non-significant as are the other independent variables in the period 1965-98. No 2. shows that this result is confirmed

Table 5: Experiments with the Agriculture Sector TFP (4)
Spillovers

Description	Constant	PVT	PUB	AUST	EDU	R^2
1. Total PVT 1962-02	-0.53	0.53	-0.22	0.42**	-0.62	0.89
2. Total PUB 1962-02	-0.81	0.22	0.06	0.31	-0.34	0.89
3. TotalPVT+TotalPUB 1962-02	-0.98	0.41	-0.13	0.48**	-0.59	0.89

for the 1965-02 period.. However, in the spillover case in 3. and 4. both `all grant stocks' for PVT in 3. combined with agriculture PUB stocks, and the combination of national stocks for both PVT and PUB in 4. show significant elasticities for all variables. The size of the elasticities reflects the percentage increase in the TFP measure corresponding to a 1 percent change in the total R&D stocks as the case may be. In 3. the return on total private stocks is about $2.5 per dollar of stocks. The return on public stocks is negative $0.96. However the importance of these experiments relates more to defining a suitable investment proxy than the estimated rate of return.

Table 6: Experiments with the Agriculture Sector TFP (5)
`Grants'

Description	Constant	PVT	PUB	AUST	EDU	R^2
1. `Grants' PVT,new shares 1965-98	-1.78	0.43	-0.14	0.47	-0.38	0.83
2. `Grants' PVT,new shares 1965-02	-1.09	0.17	0.17	0.58	-0.74*	0.86
3. TotalPVT `Grants' 1965-02	-6.03	1.50**	-1.02**	0.85**	-0.69*	0.89
4. Total PVT+Total PUB 1965-02	-4.60	1.41*	-0.95*	0.86**	-0.74*	0.88

Summary and Conclusions

The search for a better definition of private investment in R&D has had mixed results. The specification based on research associations failed to indicate a significant relationship with agricultural TFP but showed a just significant relationship for the market economy for the period 1962-2002 (option 5, Table 1).

However, the specification based on government grants to the private sector shows more promise. In the market economy (option 7, Table 1), all four independent variables show significant association with market economy TFP. In the agricultural sector (options 1. and 2.,Table 6), substituting the grants PVT variable does not relate to agricultural TFP. However, in the spillover hypothesis, the national total for stocks based on grants (options 3.and 4.,Table 6), has a definite relationship to changes in agricultural TFP. This suggests that it would be worthwhile to repeat the Johnson (1999) analysis and the Johnson *et al* analysis (2006) based on combined cross section and time series data.

In summary, the earlier MoRST idea that industries can nominate the research expenditure that applies to them is a weak one. As it happens, MoRST has dropped the idea of `output areas' from more recent surveys and publications. The presence of any spillovers at all in the science market negates the idea of specific output areas. Instead, science knowledge should be regarded as a generally available pool of knowledge and the science discovery process in industry should be concerned with determining what is useful in a particular application out of *all* that is available.

Further I now question whether the Griliches (1979) notion that science expenditure can be converted to a stock of knowledge like a stock of capital assets is a workable proposition. A stock depends on the perpetual inventory model and needs a specified rate of real depreciation. Is the accumulation of science knowledge like this? Can we find some other way of identifying the influence of what is undoubtedly a large stream of social expenditure?

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Appendix

Table A1 : DERIVATION OF 1999 ESTIMATES OF PRIVATE INVESTMENT IN R&D 1962-90

Fiscal Year Ending	GOVT/gdp actual %	PTE/gdp est %	Investment est $m
1962	0.0030	0.0015	4.31
1963	0.0029	0.0014	4.36
1964	0.0029	0.0015	5.09
1965	0.0033	0.0016	5.95
1966	0.0034	0.0017	6.82
1967	0.0038	0.0019	7.96
1968	0.0041	0.0020	8.75
1969	0.0042	0.0021	9.75
1970	0.0042	0.0021	10.78
1971	0.0044	0.0022	12.80
1972	0.0045	0.0023	15.82
1973	0.0047	0.0024	18.96
1974	0.0048	0.0024	22.05
1975	0.0053	0.0027	27.35
1976	0.0054	0.0027	31.71
1977	0.0048	0.0024	34.08
1978	0.0052	0.0026	40.40
1979	0.0060	0.0030	50.90
1980	0.0059	0.0030	59.37
1981	0.0062	0.0031	71.58
1982	0.0064	0.0033	92.36
1983	0.0064	0.0033	104.08
1984	0.0059	0.0033	115.13
1985	0.0055	0.0033	130.45
1986	0.0057	0.0032	145.37
1987	n.a.	0.0031	176.32
1988	n.a.	0.0031	191.76
1989	n.a.	0.0030	199.20
1990	0.0039	0.0028	217.20

Table A2: EXPENDITURE ON R&D BY PROVIDERS IN NEW ZEALAND

	Nominal Expenditure				Real Expenditure		
FiscYear Ending	Private Sector	Govt. Sector	Univ. Sector	Deflator $82-83	Private	Public	Total
1962	4.3	7.6	2.6	168	25.6	60.7	86.3
1963	4.4	8.1	2.8	177	24.9	61.6	86.4
1964	5.1	8.7	3.1	182	28.0	64.8	92.9
1965	5.9	10.5	3.4	185	31.9	75.1	107.0
1966	6.8	12.1	4.1	191	35.6	84.8	120.4
1967	7.9	14.2	4.8	192	41.1	99.0	140.1
1968	8.7	15.7	5.8	202	43.1	106.4	149.5
1969	9.7	17.1	6.7	210	46.2	113.3	159.5
1970	10.8	19.9	7.7	221	48.9	124.9	173.8
1971	12.8	23.1	9.8	242	52.9	136.0	188.8
1972	15.8	28.1	13.1	278	56.8	148.2	205.0
1973	19.1	33.9	17.8	307	62.2	168.4	230.6
1974	22.1	39.7	24.1	333	66.4	191.6	258.0
1975	27.4	49.4	27.6	353	77.6	218.1	295.8
1976	31.7	58.1	31.8	402	78.9	223.6	302.5
1977	34.1	62.7	30.2	486	70.2	191.2	261.3
1978	40.4	74.1	34.1	523	77.2	206.9	284.1
1979	50.9	92.4	41.2	591	86.1	226.1	312.2
1980	59.4	103.8	38.1	673	88.3	210.8	299.1
1981	71.6	128.3	47.1	774	92.5	226.6	319.1
1982	92.4	163.5	55.5	894	103.4	245.0	348.3
1983	104.1	184.5	59.9	1000	104.1	244.4	348.5
1984	115.1	187.9	61.6	1080	106.6	231.0	337.6
1985	130.4	197.1	64.1	1164	112.0	224.4	336.4
1986	145.4	230.7	84.7	1329	109.4	237.3	346.7
1987	176.3	226.1	105.2	1572	112.2	210.8	322.9
1988	191.7	249.4	113.9	1763	108.7	206.1	314.8
1989	199.2	259.1	137.9	1910	104.3	207.9	312.1
1990	217.2	290.2	139.2	2017	107.7	212.9	320.6
1991	217.1	318.2	166.3	2069	104.9	234.2	339.1
1992	222.7	317.2	177.1	2096	106.3	235.8	342.1
1993	229.2	312.4	232.4	2136	107.3	255.1	362.4
1994	263.3	343.4	233.5	2178	120.9	264.9	385.8
1995	257.1	358.1	254.1	2214	116.1	276.5	392.6
1996	252.5	375.6	273.5	2258	111.8	287.5	399.3
1997	282.0	389.0	340.0	2287	123.3	318.7	442.0
1998	312.5	391.3	403.6	2335	133.8	340.4	474.2
1999	316.0	387.0	372.0	2353	134.3	322.6	456.9
2000	324.1	393.1	374.1	2354	137.6	325.9	463.5
2001	367.0	421.0	402.0	2436	150.6	337.8	488.4
2002	419.4	453.1	435.8	2529	165.8	351.5	517.3
2003	470.7	472.1	454.8	2543	185.1	364.5	549.6
2004	522.0	491.1	454.8	2637	198.0	358.7	556.7

Table A3: TOTAL MARKET R&D STOCK AT 5% DEPRECIATION
$'83

FiscalYear	Private	Public	Total[1]
1961-62[2]	170.6	404.7	575.3
1963	186.9	446.0	633.0
1964	205.6	488.6	694.2
1965	227.2	539.3	766.5
1966	251.5	597.1	848.6
1967	280.0	666.2	946.3
1968	309.1	739.4	1048.5
1969	339.8	815.7	1155.6
1970	371.7	899.8	1271.5
1971	406.0	990.8	1396.8
1972	442.6	1089.5	1532.0
1973	482.6	1203.4	1686.0
1974	524.9	1334.8	1859.7
1975	576.2	1486.2	2062.4
1976	626.3	1635.5	2261.8
1977	665.1	1744.9	2410.0
1978	709.1	1864.5	2573.7
1979	759.8	1997.4	2757.2
1980	810.1	2108.3	2918.4
1981	862.1	2229.5	3091.6
1982	922.3	2363.0	3285.4
1983	980.3	2489.3	3469.6
1984	1037.9	2595.8	3633.7
1985	1098.0	2690.4	3788.4
1986	1152.5	2793.2	3945.7
1987	1207.0	2864.3	4071.4
1988	1255.4	2927.2	4182.6
1989	1296.9	2988.7	4285.6
1990	1339.8	3052.1	4391.9
1991	1377.7	3133.7	4511.4
1992	1415.1	3212.8	4627.9
1993	1451.6	3307.3	4758.9
1994	1499.9	3406.8	4906.7
1995	1541.1	3512.9	5054.0
1996	1575.8	3624.8	5200.6
1997	1620.3	3762.3	5382.6
1998	1673.1	3914.5	5587.6
1999	1723.7	4041.4	5765.1
2000	1775.2	4165.2	5940.4
2001	1837.0	4294.8	6131.8
2002	1910.9	4431.5	6342.4
2003	2006.4	4571.8	6578.2
2004	2103.9	4701.9	6805.8

Notes:

1 Starting stock = $86.3/(0.1 + 0.05)
= $575.3m (in $1982-83)
0.1 is the growth rate of R&D expenditure 1962-72
0.05 is the annual depreciation rate

2 End of year stock

Table A4: REVISED PRIVATE INVESTMENT AND STOCK $m

Fiscal Year	Current Inv	Real Inv	Res. Assns. Stock
1961-62	1.8	11.0	73.4
1963	2.4	13.5	83.2
1964	2.5	14.0	93.0
1965	3.8	20.4	108.7
1966	4.4	22.9	126.2
1967	6.2	32.3	152.2
1968	6.9	34.2	178.7
1969	8.2	39.0	208.7
1970	9.6	43.3	241.6
1971	10.3	42.8	272.3
1972	12.4	44.5	303.2
1973	12.0	39.1	327.1
1974	13.7	41.2	352.0
1975	17.0	48.0	382.4
1976	18.7	46.5	409.8
1977	20.3	41.9	431.2
1978	24.7	47.2	456.8
1979	22.5	38.1	472.1
1980	32.4	48.1	496.6
1981	39.0	50.4	522.2
1982	50.0	55.9	552.0
1983	59.1	59.1	583.5
1984	63.9	59.1	613.5
1985	68.9	59.2	642.1
1986	83.5	62.8	672.8
1987	113.0	71.9	711.0
1988	192.0	108.9	784.4
1989	205.3	107.5	852.6
1990	217.2	107.7	917.7
1991	217.1	104.9	976.7
1992	222.7	106.3	1034.1
1993	229.2	107.3	1089.7
1994	263.3	120.9	1156.1
1995	257.1	116.1	1214.5
1996	252.5	111.8	1265.6
1997	282.0	123.3	1325.6
1998	312.5	133.8	1393.1
1999	316.0	134.3	1457.7
2000	324.1	137.6	1522.5
2001	367.0	150.6	1596.9
2002	419.4	165.8	1682.9
2003	470.7	191.0	1789.7
2004	522.0	197.9	1898.2

Table A5: SECTOR SHARES FOR 1989-90

	PRIVATE 1999 shares	SHARES Revised	PUBLIC 1999 shares	SHARES Revised
Agriculture	0.086	0.0543	0.374	0.2967
Fishing	0.005	0.0055	0.066	0.0488
Forestry	0.009	0.0096	0.051	0.0387
Pr Processing	0.340	0.3253	0.062	0.0521
Manufacturing	0.291	0.3258	0.092	0.0892
Building	0.018	0.0239	0.002	0.0078
Energy	0.034	0.0277	0.005	0.0102
Transport	0.024	0.0217	0.009	0.0076
Services	0.193	0.2060	0.339	0.4523

Note: Private shares do not vary between 1962 and 1990 whereas public shares do vary. Revised shares take into account university grants by output areas. Public shares available on request.

Source: MoRST (various)

Table A6: STRUCTURE OF `GRANTS' VARIABLE

Fisc Years	Grants $th/nom	Raised Total $th/nom	Real Exp $m	Real stock $m @ 0.05%
64-5	1412	10639.42	57.51	383.40
65-6	1737	13088.30	68.53	432.76
66-7	1910	14391.85	74.96	486.08
67-8	2136	16094.76	79.68	541.45
68-9	2429	18302.52	87.15	601.53
69-0	2723	20517.81	92.84	664.30
70-1	2395	18046.33	74.57	705.65
71-2	2989	22522.12	81.01	751.39
72-3	3628	27336.98	89.05	802.86
73-4	4124	31074.34	93.32	856.04
74-5	4613	34758.96	98.47	911.70
75-6	5426	40884.91	101.70	967.82
76-7	5682	42813.87	88.09	1007.52
77-8	6179	46558.77	89.02	1046.17
78-9	9369	70595.42	119.45	1113.31
79-0	12404	93464.14	138.88	1196.52
80-1	14275	107562.13	138.97	1275.67
81-2	16307	122873.25	137.44	1349.32
82-3	18007	135682.75	135.68	1417.54
83-4	16237	122345.80	113.28	1459.95
84-5	17248	129963.68	111.65	1498.60
85-6	25849	194772.22	146.56	1570.23
86-7	27806	209518.21	133.28	1625.00
87-8	28013	211077.96	119.73	1663.47
88-9	28455	214408.43	112.26	1692.56
89-0	28800	217008.00	107.68	1715.61
90-1			104.88	1734.71
91-2			106.25	1754.23
92-3			107.30	1773.82
93-4			120.89	1806.02
94-5			116.08	1831.80
95-6			111.82	1852.03
96-7			123.30	1882.73
97-8			133.80	1922.40
98-9			134.30	1960.58
99-0			137.60	2000.15
00-1			150.60	2050.74
01-2			165.80	2114.00
02-3			191.00	2199.30
03-4			197.90	2287.24

Notes: Total investment is estimated in proportion to the grants made so as to be equivalent to the MoRST data for 1989-90. Up to 1988-89 this gives a revised estimate of real private expenditure on R&D. Thereafter, the MoRST investment is shown. Since the starting stock is amortised at the expenditure level of 1964-65, the whole stock series is revised.
Source: NZ YearBooks