Research and Development Purchasing Power Parities for New Zealand Industries and Public and Tertiary Research Institutions

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ABSTRACT

A nation's R&D expenditure represents present income foregone to achieve future technological progress. Technological progress is a key determinant of international competitiveness, on which nations rely to maintain and enhance socio-economic well-being.

It is well-accepted that in order to make international comparisons of aggregate real R&D expenditure and to assess its inflation over time it is necessary to deflate nominal R&D expenditures at sub-levels of public and private sectors using appropriate price deflators (PPPs). These sub-level PPPs vary with sub-level and with the skills and disciplines of researchers.

In this study we estimate average R&D salaries and average overhead costs at sub-levels of (i) industry sector and (ii) socio-economic category for business, government and tertiary research organisations using data from the 2004, 2006 and 2008 New Zealand R&D Surveys. We use two different methods – OLS regression, and a weighted cost share allocation using data from Department of Labour's 2006 Jobs and Tertiary Education Indicators – to apportion total salaries and total overhead costs across: (i) researchers; (ii) technicians and (iii) support staff.

We calculate sub-level PPPs using our two methods and calculate corresponding results using 2006 data from the USA Bureau of Labor Statistics. We compare and discuss results.

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1. INTRODUCTION[1]

Research and development (R&D) supports the technological progress of a nation's enterprises. Technological progress is the only sustainable pathway to a nation's long-term productivity growth, which is essential for its long-term international competitiveness.

In order to study the contribution of R&D to economic growth and productivity across different countries, it is useful to have an estimate of the price of a unit of R&D in each country.

One use of an R&D unit price[2] is to correct domestic R&D expenditure for the effect of inflation, so that we can assess the causal links between real R&D and economic growth and productivity in real terms. Another use[3] of an R&D unit price is to construct estimates of purchasing power parities for R&D (R&D PPP) for each country. We can use the R&D PPP to deflate R&D expenditure to produce estimates of real R&D in a common currency. One further use[4] of an R&D unit price is to express R&D investment in accounting terms– such as for the construction of R&D satellite accounts in national accounts.

In all nations, including New Zealand, policy makers are interested in: (i) links between R&D and productivity and economic growth; (ii) comparing real expenditure on R&D with other nations (because our nominal figures are very low in the area of business expenditure on R&D); and (iii) estimating the capital stock of R&D in the national accounts (so as to join other nations in this initiative to supplement the national accounts).

Part of the difficulty in measuring R&D unit prices arises because R&D is an intangible asset that has spillover benefits over time. The cost of R&D can vary between users because of their different capacities to exploit the R&D

[1] We gratefully acknowledge helpful discussions with colleagues at Statistics New Zealand, Department of Labour and the National Science Foundation, USA, in the preparation of this study.

[2] Jankowski Jr, John, E. (1993), *Research Policy* 22, 195 – 205, "Do we need a price index for Industrial R&D", Elsevier Science Publishers B.V., North Holland

[3] Dougherty, Sean M, Inklaar, Robert, McGukin, Robert H. and Bart Van Ark (2007), "International Comparisons of R&D Expenditure: Does an R&D PPP make a difference", *NBER Working Paper 12829.*

[4] Copeland, Adam, Medeiros, Gabriel W. and Carol A. Robbins (2007), "Estimating Prices for R&D Investment in the 2007 R&D Satellite Account" , *Bureau of Economic Analysis/National Science Foundation 2007 R&D Satellite Account Background Paper,* Bureau of Economic Analysis, US Department of Commerce.

investment and to exclusively appropriate the benefits. Difficulty also arises from the paucity of R&D data at levels of aggregation required by economic researchers. For example, while national aggregates of R&D are available, policy makers are often interested in aggregates at sub-national levels such as by: (i) industry; (ii) occupation; (iii) research area; (iv) geographic location; etc. R&D unit prices vary widely at these sub-national levels.

Dougherty et al (2007) report that there is little empirical work on R&D price indices that can be used as proxies for R&D prices. Those authors provide a helpful account of earlier studies in this area. They note the well-cited comments of Zvi Griliches in the 1980s that there is a lack of reliable information on R&D prices.

R&D Unit Prices

Copeland et al[5] report three ways we can proxy R&D unit prices:

1. as an estimate of the aggregate of change in profits of an enterprise over time due to R&D;
2. as an input cost – the cost of producing a unit of R&D;
3. as an output price – the price at which a unit of R&D is subsequently sold.

R&D outputs can include a new product or an improved process or an intangible item such as a design or a patent. The prices for these are difficult to measure and many factors can influence the downstream price of outputs.

In studies of R&D at the industry level, the output price of a unit of industrial production has been used as a proxy for the R&D unit price. The main shortcoming of this approach is that industrial output prices are not expected to be strongly correlated with R&D output prices. However, as noted by Dougherty, this industry-specific approach is more accurate than one that uses the unit price of output at the national level as an identical proxy for all industries.

In a previous study[6] of ours, we used estimates of industry output prices as proxies for R&D output prices to calculate R&D PPPs for several nations. We

[5] Refer Copeland above

used these to calculate estimates of real business expenditure on R&D (BERD) to compare New Zealand's real BERD at the industry level with that for other nations. In this context a "real" measure represents a measure of value after the influence of relative price differentials between nations has been removed.

This Study

In this study we focus our attention on R&D input costs in an effort to estimate R&D unit prices at the industry level. Previous studies[7] have shown that labour costs; purchased goods and purchased services are the main components of the R&D unit input price. Purchased goods include materials costs (raw non-durable goods). Purchased services include overhead costs such as building rent.

We estimate average wages of science workers and average overhead costs per worker in selected industries using unit record data from Research and Development Surveys for New Zealand in the years: 2004, 2006 and 2008. We also calculate average wages of researchers for the USA using Bureau of Labor Statistics (BLS) data for corresponding industries.

We use two different methodologies to calculate average wages from the New Zealand data, one methodology to calculate average overhead costs for the New Zealand data, and another methodology for the USA data.

We then calculate New Zealand R&D unit prices at each industry level by summing average wage (two methodologies) and average overhead cost for the New Zealand data. This is a variant of the approach used to calculate the Jaffe-Griliches deflator[8].

We then calculate R&D unit price indexes (basis 2004) for each of 2004-06 and 2007-08 at the industry level for New Zealand with the R&D unit prices and for USA with average wages.

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[6] Debski, I., R. White and J. Williams (2008) "Business Expenditure on Research and Development in New Zealand – future potential and future industries, Ministry of Research, Science and Technology, Wellington New Zealand. http://www.morst.govt.nz/publications/research-reports/berd-in-nz/

[7] Refer Dougherty above

[8] Griliches, Z. (1984), Comment on Edwin Mansfield's paper entitled "R&D and Innovation: Some Empirical Findings" Chapter 6 in "R&D, Patents and Productivity", Griliches, Z. ed, National Bureau of Economic Research, 1984, The University of Chicago Press, Chicago.

We calculate R&D PPPs for New Zealand as the relative price of an R&D unit in US dollars at each industry level.

We briefly compare results for different industries and for different time periods.

2. METHODOLOGY

(i) The Weighted Average Methodology for NZ Annual Average Wages

In the weighted average (WA) methodology for the New Zealand data, average annual wages were estimated for R&D personnel. For each unit record, data are available for:

(i) aggregate wages (W_i) for each business unit i

(ii) numbers in FTEs of researchers (R_i); technicians (T_i); and support staff (S_i) in each business unit i.

Let r_i, t_i; and s_i be the unknown respective average wages for researchers, technicians and support staff employed in each business unit i.

Then we can write the following as an equality:

$$W_i = R_i r_i + T_i t_i + S_i s_i \quad \text{.....1}$$

Let us assume that the ratios of

$r_i : t_i : s_i$ are the same as the ratios of

$r : t : s$

Where r, t and s are the known average wages for these R&D personnel for a particular occupation class.

In this study we derive these ratios of average wages by occupation class from 2006 Census data reported in the Jobs and Tertiary Education Indicator (JETI) database. JETI was constructed by the Department of Labour using Statistics New Zealand Labour Cost Index data.

Then we can write the following ratios:

$$r_i/t_i = r/t \quad \text{.....2}$$

$$r_i/s_i = r/s \quad \text{.....3}$$

We have three equations to solve for each of r_i, t_i and s_i.

We can derive the following equation for r_i :

$$r_i = R_i.r/[R_i.r + T_i.t + S_i.s] \quad \text{.....4}$$

and similar equations for t_i and s_i.

We estimate average annual values of r_j, t_j and s_j for each industry j which each contain i enterprises using equations such s the following:

$$r_j = (1/n_i).\ {}_i\Sigma r_i \quad \text{.....5}$$

(ii) The Weighted Average Methodology for NZ Average Annual Overhead Costs

We assume that total overhead costs for each business unit are allocated to personnel pro rata the ratios r, t and s obtained as described above.

(iii) The OLS Methodology for NZ Annual Average Wages

In the OLS methodology for New Zealand data, the average annual wages for industry groups expressed as r_j, t_j and s_j above were estimated as coefficients r, t and s of the following multivariate OLS regression equation for each of the 2004, 2006 and 2008 years with error term ϵ_j:

$$W_j = rR_j + tT_j + sS_j + \epsilon_j \quad \text{.....6}$$

Where the data are the unit records in a selected industry group j. The basic OLS assumptions are made for the parameter estimates to be unbiased. It is acknowledged that the variance of the error terms may differ according to such factors as size of business unit within each industry group hence the

estimates may not be minimum variance estimates. In addition the error terms in each industry group may not be normally distributed.

We did not attempt to estimate the overhead costs using the OLS methodology and so the OLS methodology only provides us with wages estimates.

(iv) The Averaging Methodology for USA Annual Average Wages

An estimate of the average wage for the occupational groups "researchers" and "technicians" for the USA was made using occupational data from the BLS for the years 2003/04, 2005/06 and 2007/08.

(v) R&D Unit Prices for New Zealand

We calculated R&D unit prices by industry using a simple variant of the Jaffe-Griliches deflator[9]. We assumed that R&D unit price by industry consisted of one unit of researcher wage and one unit of overhead cost.

Hence we obtained two R&D unit price measures for New Zealand for each of the 2004, 2006 and 2008 data. One (P_{WA}) uses the researcher average annual wage from the weighted average methodology (W_{WA}). The other (P_{OLS}) uses the average annual wage from the OLS methodology (W_{OLS}). Both use the overhead cost estimated from the weighted average methodology (O_{WA}):

$$P_{WA} = W_{WA} + O_{WA} \qquad \text{.....7}$$

$$P_{OLS} = W_{OLS} + O_{WA} \qquad \text{.....8}$$

(vi) R&D Unit Price Indexes

We calculated an index series – basis 2004 – (denoted by I) for each of the WA and OLS price series above by industry for each of the 2006 and 2008

[9] Refer Griliches (above)

years by dividing the 2006 and 2008 R&D unit prices above by the corresponding 2004 data:

$$^{2006}I_{WA} = {}^{2006}P_{WA}/{}^{2004}P_{WA} \quad \text{.....9}$$

$$^{2008}I_{WA} = {}^{2008}P_{WA}/{}^{2004}P_{WA} \quad \text{.....10}$$

$$^{2006}I_{OLS} = {}^{2006}P_{OLS}/{}^{2004}P_{OLS} \quad \text{.....11}$$

$$^{2008}I_{OLS} = {}^{2008}P_{OLS}/{}^{2004}P_{OLS} \quad \text{.....12}$$

We also calculated an R&D unit price index series for the USA by assuming that the annual average researcher wage for the USA based on the BLS data was a proxy for 50% of the R&D unit price, as $^{2004}P_{BLS}$, $^{2006}P_{BLS}$, and $^{2008}P_{BLS}$ for each of the 2003/04, 2005/06 and 2007/08 years respectively.

$$^{2004}P_{BLS} = 2 \times {}^{2004}W_{BLS} \quad \text{.....13}$$

$$^{2006}P_{BLS} = 2 \times {}^{2006}W_{BLS} \quad \text{.....14}$$

$$^{2008}P_{BLS} = 2 \times {}^{2008}W_{BLS} \quad \text{.....15}$$

The above assumption helps us to calculate an index series for the USA – basis 2004. We do this by industry for each of the 2006 and 2008 years by dividing the 2006 and 2008 R&D unit prices above by the corresponding 2004 data:

$$^{2006}I_{BLS} = {}^{2006}P_{BLS}/{}^{2004}P_{BLS} \quad \text{.....16}$$

$$^{2008}I_{BLS} = {}^{2008}P_{BLS}/{}^{2004}P_{BLS} \quad \text{.....17}$$

3. DATA

WA and OLS Data

Statistics New Zealand (SNZ) and the Ministry of Science, Research and Technology (MoRST) jointly conducted the Research and Development in New Zealand Survey 2006, and produced reports of the results of this survey.

The unit data collected by this survey are from a stratified sample of approximately 3,500 New Zealand business units from the private sector, higher education sector and public sector.

The unit data include unit expenditure on R&D disaggregated into five categories: (i) wages and salaries, (ii) redundancy and severance payments, (iii) other current R&D expenditure, (iv) capital expenditure lands and buildings, and (v) capital expenditure plant equipment machinery vehicles capitalised software and other assets.

The unit data include unit personnel working on R&D disaggregated into three occupation categories (researcher, technicians, other supporting staff) and two measurement methods (headcount as at 30 June 2006, full time equivalents during the year ended 30 June 2006).

The unit data include unit industry disaggregated by ANZSIC (1996) industry sector code. The unit data include unit socio-economic objective(s) (SEO) disaggregated by 20 specific research purpose sectors.

Since unit expenditure data are not disaggregated by occupation category, it is not possible to directly determine average salary or average overhead per employee by occupation type. Some prior assumptions need to be made about the relative ratios of these in order to estimate them.

We use the relative weights that are available in the Department of Labour (DOL) Jobs and Tertiary Education Indicator User Guide (JETI).

We assume that the relevant data for occupation classes for the three personnel groups in our study are given by data in the JETI database with the following NZSCO codes:

- 21 (physical science, mathematical and engineering professionals) for researchers;

- 31 (physical science, and engineering associate professionals) for technicians; and
- 41 (office clerks) for support staff.

We assume that the 2004 and 2008 ratios are the same as those for the case of the 2006 JETI data.

They correspond reasonably well with other JETI data showing most common occupations in Scientific Research organisations.

They correspond with publicly available Statistics New Zealand labour cost index (LCI) data over time, and so can be used longitudinally with R&D survey data from 2004 and 2008.

This data set has been parsed to eliminate low salary (assumed to be student or unpaid researcher) and high salary (low FTE contractor) outliers; less than 2% of the FTEs have been classified as outliers in this way.

Counts and averages reported are based on whole rounded numbers of FTEs, not on number of business units.

BLS Data

USA annual wage data by industry from year 2003 to year 2008 were collected from the BLS website[10]. The BLS data produce average wage estimates for a particular occupation for specific industries. In this study we used data at the four digit level of the Standard Occupational Classification (SOC) to identify researchers and technicians. For researchers, the 1900 to 1930 series were used and these series consisted of life scientists, physicists and social scientists. For technicians, the 1940 series was selected as the equivalent for life scientist technicians, physicist technicians and social science technicians.

The BLS data are coded by industry groups with the NACIS07 classification (NACIS02 prior to 2007). We generated a mapping table to identify the relevant industries between the two countries.

[10] http://www.bls.gov/oes/2008/may/oes_nat.htm#b19-0000

In order to be consistent with the timeframe of the New Zealand R&D Survey data, the annual BLS data were aggregated to a two year period average. Two consecutive years' (ie 2003 and 2004) wage data within the same industry were aggregated and then divided by the total employees reported in specific industries. It is important to note that the BLS data are averages of two years while the New Zealand R&D Survey data are collected as snapshots in two year intervals.

4 RESULTS

The results of this study are presented in Tables 1 to 7 and in Figures 1 to 4. We do not provide an error analysis for the results obtained.

We have translated all New Zealand dollar amounts into US dollars using average annual exchange rates as shown. For Tables 6 and 7 the indexes were calculated using New Zealand dollars and so the data in these tables cannot be directly derived from the USD amounts in the preceding tables.

In summary:

Tables 1– 3 show the results of the WA, OLS and BLS estimations to produce average annual salaries for researchers in the industry groups shown for three periods, in US dollars.

Table 4 shows the results of the WA estimation to produce annual average overhead per New Zealand researcher.

Table 5 shows the estimates of the R&D unit prices per New Zealand researcher obtained as the sum of the annual average wage of a researcher and the allocated overhead cost per researcher.

Tables 6 and 7 show the R&D unit price indexes with the 2004 year as basis. For New Zealand these are obtained by dividing the R&D Unit Price per New Zealand researcher (for each of 2006 and 2008) by the corresponding 2004 data. For the USA these are obtained by dividing the annual average wage per USA researcher (for each of 2006 and 2008) by the corresponding 2004 data. Hence the USA indexes do not contain any component that accounts for overhead costs.

5 DISCUSSION OF RESULTS

Distribution of Research

Figure 1 shows the distribution of New Zealand researchers. Most of the total population of researchers is employed in the public sector in universities and crown research institutes (included in scientific research business services).

R&D Unit Prices

The data in Tables 1 to 4 are important source data for the construction of the R&D unit prices, price indexes and R&D PPPs in Tables 5 to 8. In general the WA and OLS results seem reasonable estimates of annual wages for skilled people and they appear to be correlated well with each other. To analyse the correlation between the WA and OLS estimates, we simply plotted estimates by industry group for the 2008 year as a scatter plot as shown in Figure 2.

A hypothetical 45 degree line is shown where scatter plots would lie if WA and OLS estimates were identical. Instead there appears to be an interesting systematic bias in the data. The OLS estimates are higher than the WA estimates for certain industries.

We propose to investigate this further and we have benefited from helpful discussions with Statistics New Zealand on this topic. At this stage our tentative explanation is that the WA methodology has an inherent systematic bias that influences the estimates. We believe it is likely that this bias is introduced from the use of the JTEI weights which are prepared from Census data. Census data are truncated in the sense that very high annual wages above a certain level are all coded with the same wage and this is often lower than the actual wage. By comparison, the OLS methodology does not contain this bias because it is not guided by prior assumptions about the ratios of wages of different personnel.

At the same time the OLS methodology, in some cases, produces unreasonable estimates (such as negative values) and in these cases we trialled many different specifications (such as having the researcher numbers

as the only independent variable) to achieve reasonable estimates of researcher wages.

Our tentative explanation about the systematic bias is consistent with the OLS method being unrestrained in showing higher annual average wages for education and business services industries. As shown in Figure 2, these industries include our universities and CRIs where wage levels are likely to have been truncated in a Census data set.

Time Trend

We plotted WA, OLS and BLS data for the 2004, 2006 and 2008 years. These series are shown in Figures 2 to 4. In general, although we do not provide an error analysis, the WA and OLS series track in a similar way and both show a large difference to the BLS series in the 2006 year.

We propose to attempt to extrapolate the time series backwards to cover the preceding 10 years. The survey methodology for the R&D Survey was changed in 2004 and this may complicate the extrapolation somewhat.

R&D Unit Prices Inflation

Tables 6 and 7 show R&D unit price inflation by industry. In general with a few exceptions, R&D unit prices have risen for all industries for both New Zealand and the USA. The USA prices are more stable and price rises there have been smaller. The results for the business services and education industry groups, comprising CRIs and universities respectively are interesting. For both WA and OLS methods and for the BLS data, business services R&D prices have risen by a much smaller amount than education prices.

The inter-industry variation for New Zealand R&D unit prices expressed in New Zealand dollar terms appears to be much higher than for the USA prices.

R&D PPPs

In Tables 8 and 9 we show estimates of R&D PPPs for New Zealand compared with the USA. An R&D PPP is essentially the real amount of R&D that we could purchase with one US dollar in the years shown in both countries. In this

study this real amount is represented in terms of a year of researcher time. A higher value than another means more units of R&D researcher time can be purchased.

In general terms, a comparison between New Zealand industries in both years shows that real cost of R&D (relative to the USA) in Government Administration, Business Services, Education and Food, Beverage and Tobacco Industries is higher than for many other industries. Similarly, in New Zealand the real cost of R&D in communication services (relative to the USA) is lower than for many other industries. The Business Services and Education industry groups are interesting because the highest proportion of research performed in New Zealand is performed in these two sectors – in our universities and CRIs.

Looking across the period from 2003-04 to 2007-08, using the average of the WA and OLS R&D PPPs, we see that, in general, with the possible exception of (i) Agriculture and Mining and (ii) Textile and Wood Manufacturing, the real cost of R&D relative to the USA has risen from 2003-04 to 2007-08. In part we can explain this by the apparent rise in R&D unit prices (in terms of annual wages) in most New Zealand industries as discussed above. Assuming that the balance of the difference is an exchange rate effect, we can attribute the balance of the loss of purchasing power to the rise in the value of the NZ dollar from 0.63 USD to 0.73 USD in this period. In doing so we are assuming that other factors such as quality improvements in researchers are not significant.

Summary

With our new suite of industry-specific price indicators, we can focus on changes in nominal and real prices of R&D at the industry level. We have based this study on data from three time periods. We propose to extrapolate the model backwards to include ten years of previous data. At the same time the models can be used to collect and investigate future time trends in R&D price inflation and real R&D costs. With time trend data we can immediately see how R&D price inflation is tracking in New Zealand and how the real amount of R&D expenditure at the industry level compares with that for other nations. This is useful for policy makers who wish: (i) to assess the stability

and effectiveness of science funding over time and (ii) to compare real expenditure on R&D between nations.

Table 1

Average Annual Salaries 2003-04 (in US dollars)

	WA-NZ	OLS-NZ	BLS-USA
	NZ/US 0.63	NZ/US 0.63	NZ/US 0.63
Agriculture and Mining	$48,352	$61,208	$69,792
Food, Beverage and Tobacco	$39,058	$45,850	$47,743
Textile and Wood Manufacturing	$35,678	$35,224	$50,561
Communication Services	$37,440	$24,366	$67,154
Petroleum and Non-Metallic Mineral Manufacturing	$42,704	$43,121	$60,567
Metal, Machinery and Other Manufacturing	$37,063	$32,149	$67,549
Construction	$24,107	$53,787	$54,526
Wholesale Trade	$38,143	$43,327	$63,388
Financial Services	$36,596	$10,269	$59,623
Business Services (including Scientific Research Services)	$39,884	$43,615	$45,242
Government Administration	$51,164	$86,568	$57,119
Education (including Higher Education)	$41,493	$40,247	$45,934
Health Services	$29,051	$68,966	$61,554
Community Services	$33,050	$22,246	$46,855

Table 2

Average Annual Salaries 2004-05 (in US dollars)

	WA-NZ	OLS-NZ	BLS-USA
	NZ/US 0.68	NZ/US 0.68	NZ/US 0.68
Agriculture and Mining	$54,885	$55,480	$85,286
Food, Beverage and Tobacco	$65,146	$68,298	$52,983
Textile and Wood Manufacturing	$57,901	$80,935	$54,561
Communication Services	$38,902	$34,865	$72,140
Petroleum and Non-Metallic Mineral Manufacturing	$47,523	$30,387	$66,430
Metal, Machinery and Other Manufacturing	$42,697	$35,813	$73,621
Construction	$51,236	$59,299	$61,242
Wholesale Trade	$49,178	$50,624	$68,628
Financial Services	$57,244	$89,473	$64,854
Business Services (including Scientific Research Services)	$50,822	$57,069	$61,092
Government Administration	$55,884	$56,016	$63,616
Education (including Higher Education)	$48,532	$75,869	$50,229
Health Services	$41,349	$40,492	$72,220
Community Services	$40,639	$31,175	$55,323

Table 3

Average Annual Salaries 2007-08 (in US dollars)

	WA-NZ	OLS-NZ	BLS-USA
	NZ/US 0.73	NZ/US 0.73	NZ/US 0.73
Agriculture and Mining	$62,893	$42,442	$87,227
Food, Beverage and Tobacco	$59,810	$75,713	$53,887
Textile and Wood Manufacturing	$68,520	$11,193	$55,388
Communication Services	$42,828	$31,444	$72,257
Petroleum and Non-Metallic Mineral Manufacturing	$57,956	$40,696	$69,002
Metal, Machinery and Other Manufacturing	$51,796	$46,321	$74,901
Construction	$50,920	$68,561	$61,267
Wholesale Trade	$59,387	$69,439	$71,511
Financial Services	$61,488	$41,617	$64,461
Business Services (including Scientific Research Services)	$55,345	$69,439	$63,712
Government Administration	$86,076	$137,468	$61,719
Education (including Higher Education)	$67,886	$94,423	$83,913
Health Services	$48,942	$54,233	$71,233
Community Services	$38,205	$32,938	$57,032

Table 4

Average Annual Overhead for New Zealand from WA Method (in US dollars)

	2003-04	2005-06	2007-08
	NZ/US 0.63	NZ/US 0.68	NZ/US 0.73
Agriculture and Mining	$80,411	$55,045	$151,127
Food, Beverage and Tobacco	$26,543	$70,093	$59,402
Textile and Wood Manufacturing	$15,748	$58,986	$41,473
Communication Services	$10,659	$120,596	$42,341
Petroleum and Non-Metallic Mineral Manufacturing	$21,396	$46,358	$65,724
Metal, Machinery and Other Manufacturing	$16,954	$24,341	$33,280
Construction	$9,190	$40,429	$62,664
Wholesale Trade	$39,389	$34,973	$54,428
Financial Services	$26,640	$38,453	$38,140
Business Services (including Scientific Research Services)	$43,994	$46,172	$65,011
Government Administration	$60,830	$56,446	$112,857
Education (including Higher Education)	$22,888	$27,147	$47,832
Health Services	$17,856	$18,857	$78,758
Community Services	$28,970	$26,825	$68,595

Table 5

R&D Unit Prices (in US dollars)

	2004	2004	2006	2006	2008	2008
	WA-NZ	OLS-NZ	WA-NZ	OLS-NZ	WA-NZ	OLS-NZ
	NZ/US 0.63	NZ/US 0.63	NZ/US 0.68	NZ/US 0.68	NZ/US 0.73	NZ/US 0.73
Agriculture and Mining	$128,763	$141,619	$109,930	$110,525	$173,216	$118,652
Food, Beverage and Tobacco	$65,601	$72,393	$135,239	$138,391	$103,174	$148,567
Textile and Wood Manufacturing	$51,426	$50,972	$116,886	$139,920	$98,795	$150,209
Communication Services	$48,099	$35,025	$159,498	$155,461	$73,737	$166,892
Petroleum and Non-Metallic Mineral Manufacturing	$64,100	$64,517	$93,881	$76,745	$105,935	$82,388
Metal, Machinery and Other Manufacturing	$54,017	$49,103	$67,038	$60,154	$76,091	$64,577
Construction	$33,297	$62,977	$91,665	$99,728	$96,664	$107,061
Wholesale Trade	$77,532	$82,716	$84,151	$85,597	$99,120	$91,891
Financial Services	$63,236	$36,910	$95,697	$127,926	$89,330	$137,332
Business Services (including Scientific Research Services)	$83,878	$87,609	$96,994	$103,241	$102,803	$110,832
Government Administration	$111,994	$147,398	$112,331	$112,462	$168,461	$120,731
Education (including Higher Education)	$64,382	$63,135	$75,679	$103,016	$102,803	$110,591
Health Services	$46,908	$86,822	$60,206	$59,348	$106,435	$63,712
Community Services	$62,020	$51,216	$67,464	$58,000	$88,279	$62,264

Table 6

R&D Unit Price Indexes 2005-06

Industry	WA-NZ (NZD)	OLS-NZ (NZD)	BLS-USA (USD)
	2004 base year (=1)	2004 base year (=1)	2003-04 base year (=1)
Agriculture and Mining	0.79	0.72	1.22
Food, Beverage and Tobacco	1.91	1.77	1.11
Textile and Wood Manufacturing	2.11	2.54	1.08
Communication Services	3.07	4.11	1.07
Petroleum and Non-Metallic Mineral Manufacturing	1.36	1.10	1.10
Metal, Machinery and Other Manufacturing	1.15	1.13	1.09
Construction	2.55	1.47	1.12
Wholesale Trade	1.01	0.96	1.08
Financial Services	1.40	3.21	1.09
Business Services (including Scientific Research Services)	1.07	1.09	1.35
Government Administration	0.93	0.71	1.11
Education (including Higher Education)	1.09	1.51	1.09
Health Services	1.19	0.63	1.17
Community Services	1.01	1.05	1.18

Table 7

R&D Unit Price Indexes 2007-08

Industry	WA-NZ (NZD)	OLS-NZ (NZD)	BLS-USA (USD)
	2004 base year (=1)	2004 base year (=1)	2003-04 base year (=1)
Agriculture and Mining	1.16	0.93	1.25
Food, Beverage and Tobacco	1.36	1.42	1.13
Textile and Wood Manufacturing	1.66	0.70	1.10
Communication Services	1.32	1.54	1.08
Petroleum and Non-Metallic Mineral Manufacturing	1.43	1.19	1.14
Metal, Machinery and Other Manufacturing	1.22	1.24	1.11
Construction	2.51	1.57	1.12
Wholesale Trade	1.10	1.14	1.13
Financial Services	1.22	1.62	1.08
Business Services (including Scientific Research Services)	1.06	1.15	1.41
Government Administration	1.30	1.29	1.08
Education (including Higher Education)	1.38	1.77	1.83
Health Services	1.96	1.11	1.16
Community Services	1.23	1.40	1.22

Table 8

R&D PPPs based on Average Annual Wages 2007-08 with USA as basis (1 USD PPP)

	WA-NZ	OLS-NZ	BLS-USA
	NZ/US 0.73	NZ/US 0.73	NZ/US 0.73
Agriculture and Mining	1.39	2.06	1.00
Food, Beverage and Tobacco	0.90	0.71	1.00
Textile and Wood Manufacturing	0.81	4.95	1.00
Communication Services	1.69	2.30	1.00
Petroleum and Non-Metallic Mineral Manufacturing	1.19	1.70	1.00
Metal, Machinery and Other Manufacturing	1.45	1.62	1.00
Construction	1.20	0.89	1.00
Wholesale Trade	1.20	1.03	1.00
Financial Services	1.05	1.55	1.00
Business Services (including Scientific Research Services)	1.15	0.92	1.00
Government Administration	0.72	0.45	1.00
Education (including Higher Education)	1.24	0.89	1.00
Health Services	1.46	1.31	1.00
Community Services	1.49	1.73	1.00

Table 9

R&D PPPs based on Average Annual Wages 2003-04 with USA as basis (1 USD PPP)

	WA-NZ	OLS-NZ	BLS-USA
	NZ/US 0.63	NZ/US 0.63	NZ/US 0.63
Agriculture and Mining	1.44	1.14	1.00
Food, Beverage and Tobacco	1.22	1.04	1.00
Textile and Wood Manufacturing	1.42	1.44	1.00
Communication Services	1.79	2.76	1.00
Petroleum and Non-Metallic Mineral Manufacturing	1.42	1.40	1.00
Metal, Machinery and Other Manufacturing	1.82	2.10	1.00
Construction	2.26	1.01	1.00
Wholesale Trade	1.66	1.46	1.00
Financial Services	1.63	5.81	1.00
Business Services (including Scientific Research Services)	1.13	1.04	1.00
Government Administration	1.12	0.66	1.00
Education (including Higher Education)	1.11	1.14	1.00
Health Services	2.12	0.89	1.00
Community Services	1.42	2.11	1.00

Figure 1: Number of researcher FTEs 2006 by ANZSIC sector (in sector size order)

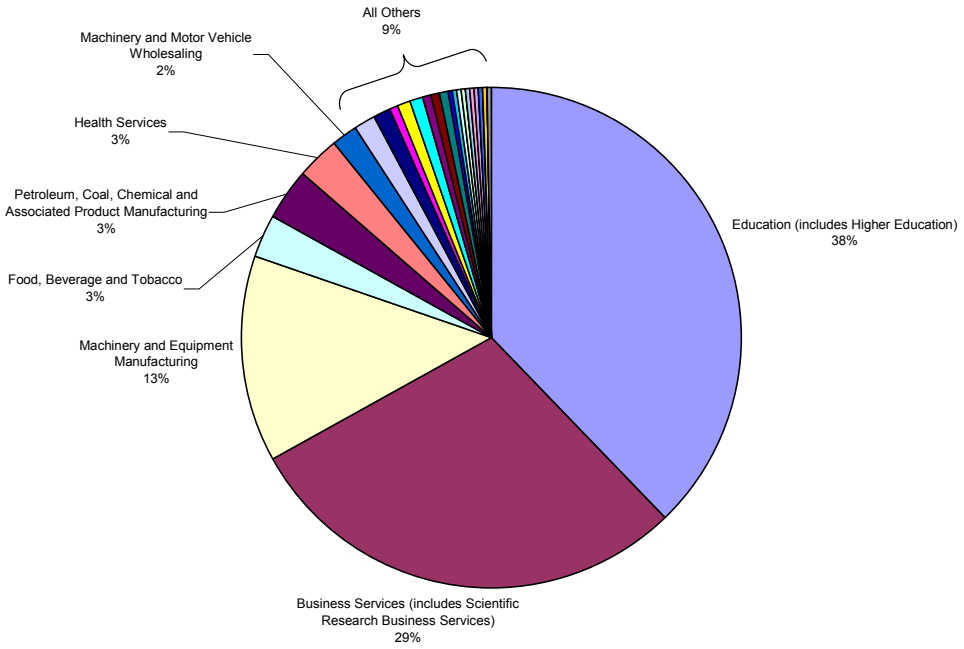

Figure 2: OLS-NZ WA-NZ for 2007-08 in NZD

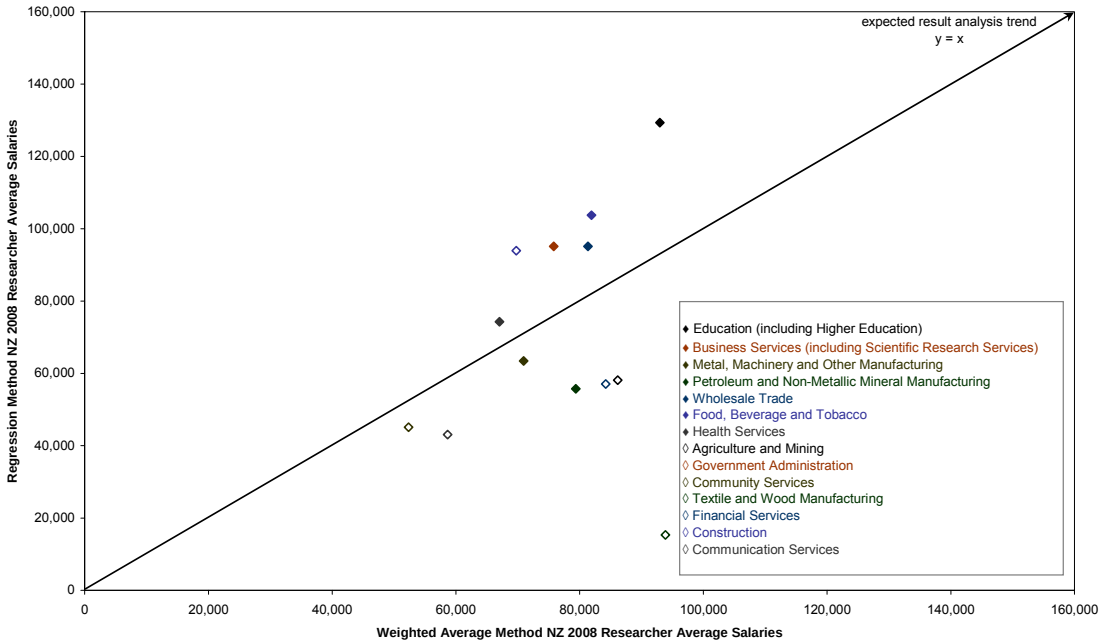

Figure 3. Average Wage Estimates WA , OLS and BLS
Agriculture and Mining

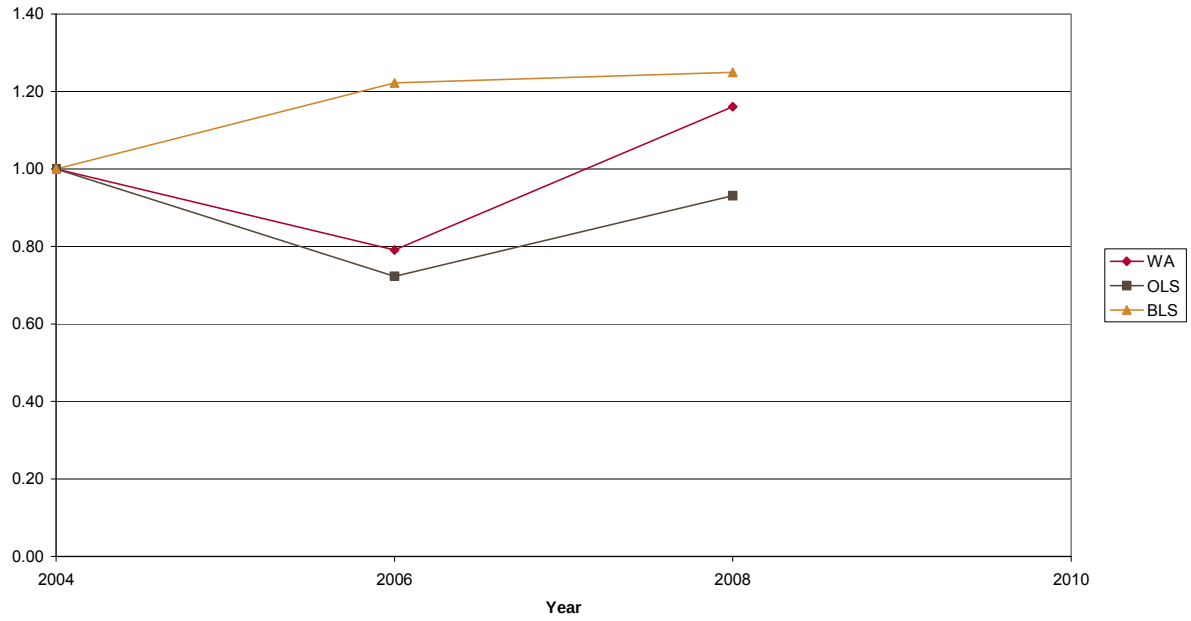

Figure 4. Average Wage Estimates WA, OLS and BLS
Food, Beverage and Tobacco

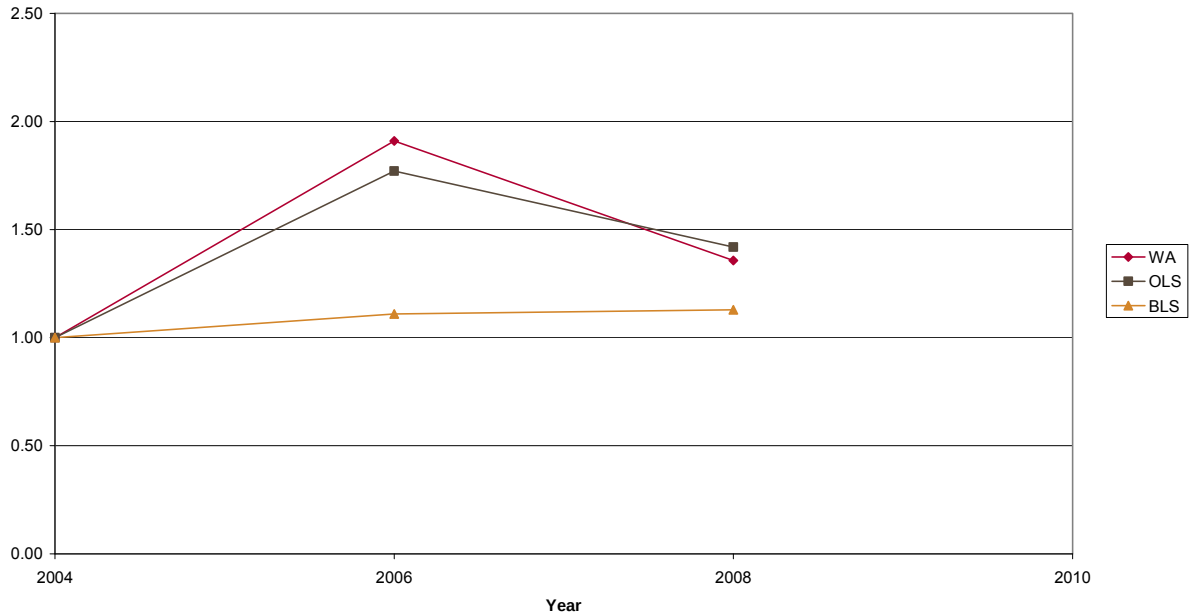

Figure 5. Average Wage Estimates WA, OLS and BLS
Textile and Wood Manufacturing