# Gender Differences in Wage Returns to Computer Skills in Australia

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ABSTRACT *This article examines how different types of computer skills influence the wages of men and women in Australia. The estimated wage effect for each type of computer use ranged from 2.8% to 7.0%. Comparing these results with earning equations which do not explicitly account for computer usage and skills reveals an associated bias on the returns to education. Wage equations which do not explicitly account for computer skills upwardly bias the returns to education by up to 68%. This bias is inversely proportional to the level of education. That is, the returns to education for individuals with lower educational qualifications are more highly biased by not accounting for computer skills than those with higher qualifications.*

*Lower levels of computer skills reward females more highly than males. Higher levels of computer skills reward males at a greater rate than females. The major findings arising from this research relates to the observable wage differential between males and females. After accounting for other measurable factors such as education, tenure, and language skills females are rewarded more highly for their computer skills than males. Indeed, if the return on computer skills were the same for females as males, the gender wage differential could be expected to increase by 13.4%. This finding suggests that computer literacy can be a more important factor in increasing the wages of females than completing high school.*

Keywords: gender wages, human capital, information technology.

## Introduction

This article explores the wage impact of using computers and how this contributes to differences in the wages of males and females in Australia. The 1980s and 1990s have been periods of significant changes in the types of jobs in which computer skills are required. Firms eager to capitalise on the technological advances available to them dramatically increased their expenditure on computer technology. Many educational institutions perceiving the importance of computer skills to future employment have encouraged all students to enrol in courses which will enhance their computer skills.

The latest Australian Bureau of Statistics data[1] on information technology suggests that in 1995–96, the total wage and salary component from information technology was AU$10.4 million dollars. Of this, 91.6% was spent by information technology specialists. Table 1 illustrates the division of wage and salaries expenses between various computer services.

Clearly, the wages and salaries expenses in the information technology industry is substantial. Table 1 represents only a conservative estimate of the effect computers have upon wages in the economy. The general adoption of computers to a wide range of jobs

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**Table 1.** Computing services for information technology, 1995–96, Australia

| **Computing service** | **Wages and salaries (AU$m)** |
|---|---|
| Data processing | 253.6 |
| Information storage and retrieval | 44.6 |
| Computer maintenance | 202.2 |
| Computer consultancy | 2176.4 |
| Total | 2676.8 |

*Source:* Australian Bureau of Statistics (ABS), 1997 *Information Technology, Australia,* Catalogue No. 8143.0

throughout the economy has been facilitated by employers perceiving that computers have the capacity to improve the productivity of the firm. In some instances, this may be achieved by replacing (relatively expensive) employees with computers, in others, computers may lead to a substitution of labour from a low-skilled workforce, to highly-skilled specialists, and in still other cases employment may increase through increases in market share which result from increases competitiveness.

In the case where the labour productivity of an employee is improved, it is possible that employees able to achieve this benefit will be rewarded for their skills by the firm in the form of higher wages. As noted by Krueger:

> [t]he new computer technology may be a complement or a substitute for skilled workers. In the former case the computer revolution is likely to lead to an expansion in earnings differentials based on skill, and in the latter case it is likely to lead to compression in skill-based differentials.[2]

This article, using the methodology identified by Krueger (1993) for the United States examines whether employees who use computers earn more as a result of applying their computer skills. Secondly, by estimating the effect on wages of different computer skills by gender, it is possible to determine whether (like other forms of education) the returns to women are lower than men.[3]

The article is structured as follows. Section I presents a brief description of the data utilised in this study, with particular reference to the computer usage variables. Section II presents the theoretical framework for the following analysis. Section III empirically estimates the effect computer usage has upon the earnings of men and women. Finally, section IV analyses the implications of these findings for education and training policy in Australia.

## Section I: Data

The data used in this study is derived from the *1993 Survey of Training and Education Experience* conducted by the Australian Bureau of Statistics (ABS).[4] This survey was conducted throughout Australia during April and May 1993, and included persons aged 15 to 64 years of age who had worked as wage and salary earners in the last 12 months and persons who, at the time of the survey, were employers, self-employed, unemployed or marginally attached to the labour force. The sample file contains 20 889 individuals. The data contains a vast array of characteristics useful to undertake research of this nature, particularly as it relates to different types of computer usage. Only employed

**Table 2.** Employee usage of computers by occupation, 1993

| Occupation | % Used computers | % of sample |
|---|---|---|
| Managers | 82.2 | 7.3 |
| Professionals | 90.7 | 15.1 |
| Paraprofessionals | 73.0 | 7.8 |
| Trades persons | 39.0 | 12.4 |
| Clerks | 89.5 | 19.2 |
| Sales and personal services | 59.7 | 16.1 |
| Machine operators | 31.3 | 7.6 |
| Labourers | 32.8 | 14.6 |
| Total | 64.2 | 100.0 |

*Notes:* (a) occupation refers to occupation with main employer.
(b) computer usage does not necessarily relate to current employment.

*Source:* Data derived from ABS 1993 *Survey of Training and Education*, Australia.

wage and salary earners who reported valid information on each of the chosen characteristics are included in this analysis. This survey is a particularly useful source of data for this analysis as it contains information not only on whether a person has ever used a computer but also the types of computer uses undertaken at work.

In the sample used for this analysis there are 5857 males and 6501 females. Characteristics which will be used as explanators for wages include tenure, age, educational qualifications, experience and language skills, unionisation and geographic location. In addition, detailed information on the type of computer skills an individual utilises at work is provided.[5]

As shown in Table 2, individuals in different occupations have varying familiarity with using computers. Professionals, clerks and managers are occupations which have the highest likelihood of employing people who have computer skills. By contrast, less than one third of Machine operators and Labourers have used computers.

Table 3 illustrates how computer usage is related to the extent of educational qualifications. That is, as the level of educational qualifications increase, so does the use of computers. At least 84% of employees with university qualifications had used a computer, whilst only 40% of employees who left school before 16 years of age had used a computer. As a result of modern educational techniques, this result is hardly surprising. The issue of most interest however, is how does the use of computers effect wages? As noted by Miller and Mulvey (1996),[6] after adjusting for human capital factors thought to affect wages, computer usage is estimated to increase the wages for males by 13% and 16% for females.

In order to determine whether there exists differences in the type of computer usage, Tables 4, 5 and 6 present information on computer usage by occupation, age, and sex. Table 4 shows the most common type of computer uses are word and data processing. Surprisingly, it is professionals that have the highest propensity to use word processing and data processing (76.1 and 55.3% respectively). However, in the context of all types of computer uses, professionals are more likely than another occupational category to use computers.

**Table 3.** Computer usage by educational qualification, 1993

| Highest qualification | % Used computers |
|---|---|
| Postgraduate degree | 92.7 |
| Degree | 83.5 |
| Other post school | 75.0 |
| High school certificate | 73.1 |
| Trade certificate | 50.8 |
| Left school 16–18 | 56.0 |
| Left school < 16 | 39.5 |

**Table 4.** Type of computer usage by occupation, Australia, 1993

| Occupation | Word processing | Data processing | Data bases | Spreadsheets | Specialist packages | Other usage |
|---|---|---|---|---|---|---|
| Managers | 57.2 | 53.9 | 51.9 | 51.1 | 21.5 | 7.3 |
| Professionals | 76.1 | 55.3 | 53.5 | 47.2 | 25.9 | 8.5 |
| Paraprofessionals | 44.5 | 45.5 | 38.7 | 24.6 | 11.8 | 4.6 |
| Trades persons | 16.0 | 21.3 | 15.2 | 9.8 | 8.3 | 5.0 |
| Clerks | 66.7 | 70.5 | 45.3 | 42.0 | 14.9 | 4.5 |
| Sales and personal services | 35.2 | 38.7 | 25.0 | 20.9 | 8.7 | 3.7 |
| Machine operators | 10.5 | 16.9 | 10.9 | 6.3 | 4.6 | 4.2 |
| Labourers | 16.4 | 20.7 | 11.1 | 9.8 | 5.2 | 3.0 |
| Total | 42.8 | 42.5 | 31.9 | 27.3 | 12.8 | 5.0 |

The nature of the work involved clearly influences the type of computers usage. For instance, although labourers and machine operators have the lowest propensity to use computers of any occupational categories, labourers are as equally likely to use spreadsheets as trades persons. Trades persons, however do not have a high probability of computer usage. Between different types of computer usage, occupational representation remains relatively similar. That is, occupational categories which have a below average usage of one computer type, and likely to have below average usage for all computer types, and *vice versa*. This may indicate that the computer literate employee will have a broad based computer experience. This would imply that computer literacy training targeting at increasing the general skills of the computer literate is working. If wages are related to computer skills, then the implication is that wage/productivity improvements for less skilled employees could be achieved through basic, well targeted computer familiarisation. These hypotheses will be explored in the following sections.

## Section II: Framework

The standard human capital model can be summarised as follows:

$$\ln W = b_0 + b_1 X_1 + b_n U_n$$

where $X_1$ is a vector of human capital, personal and job-related characteristics of the ith individual, $U_n$ is a randomly distributed error term, $\mathcal{N}(0.1)$.

**Table 5.** Computer usage by age and sex, Australia, 1993

| Age categories | % Males who have used a computer | % of sample of males | % Females who have used a computer | % of sample of females |
|---|---|---|---|---|
| Aged 15–19 years | 52.6 | 5.6 | 67.7 | 6.0 |
| Aged 20–24 years | 59.4 | 12.9 | 77.4 | 15.1 |
| Aged 25–34 years | 64.0 | 27.4 | 74.3 | 27.8 |
| Aged 35–44 years | 67.0 | 27.4 | 48.4 | 28.2 |
| Aged 45–54 years | 58.8 | 18.9 | 57.8 | 18.2 |
| Aged 55 plus | 39.9 | 7.8 | 41.2 | 4.7 |
| Total | 60.7 | 100.0 | 68.0 | 100.0 |

**Table 6.** Type of computer usage by sex, 1993

| Type of computer usage | % Males used | % Sample | % Females used | % Sample |
|---|---|---|---|---|
| Wordprocessor | 36.8 | 45.2 | 49.5 | 54.8 |
| Data processing | 40.7 | 49.7 | 45.1 | 50.3 |
| Data bases | 34.2 | 56.4 | 29.4 | 43.6 |
| Spreadsheets | 28.4 | 54.6 | 26.2 | 45.4 |
| Specialist packages | 16.2 | 66.7 | 9.0 | 33.3 |
| Other uses | 5.9 | 61.7 | 4.0 | 38.3 |

As a result of the level of detail in the data used in this study, the simple model can be extended to:

$$\ln W = b_0 + b_1X_1 + C_{wp}a_1 + C_{dp}a_2 + C_{db}a_3 + C_s a_4 + C_{sp}a_5 + C_{oth}a_6$$

where $X_1$ remains a vector of human capital, personal and job-related characteristics of the ith individual, $b_0$ is a constant, and $C_{wp}...C_{oth}$ represent dichotomous dummy variables indicating whether an individual has used word processing, data processing, data bases, spreadsheets, specialist packages or other uses respectively. The coefficients $a_1$ to $a_6$ represent the estimated wage effect from each of the computer uses.

Since for some occupations, the use of computers is a prerequisite for being in that occupation (for example, data entry worker, computer programmer), there is some question on whether occupational dummies should be included. Hence earnings equations are estimated with and without occupational variables.

## Section III: Empirical Results

Table 7 presents heteroskedasticity-corrected Ordinary Least Squares (OLS) estimates of equation (2).[7] The results indicate the effect of computer use on wage differs between different types of uses. In instances where computer usage was statistically significantly associated with wage effects, the magnitude of the wage effect (see Table 8) ranged from 2.0% and 6.2%. For word processing, data processing and data base experience, the wage effect is estimated to be lower than for spreadsheet, specialist packages and programming or systems development experience.

The magnitude of return to computer usage in some cases exceeded the returns to lower levels of formal educational qualifications (other post school qualifications, high school qualifications, and early school leavers). It should be recalled however, that in some instances, formal qualifications would generally be required before experience in

**Table 7.** Wage effect of computer usage, by sex

| | Coefficient | |
|---|---|---|
| | Equation (3) | Equation (4) |
| Word process | 0.020* | 0.039* |
| Data process | − 0.001 | − 0.006 |
| Data base | 0.037* | 0.046* |
| Spreadsheet | 0.050* | 0.053* |
| Specialist | 0.048* | 0.062* |
| Programming | 0.043* | 0.047* |
| Other | 0.013 | 0.025 |

*Notes:* *significant at 5% level.
Equation 4 represents wage equations not corrected for occupational distribution.

some computer uses would be acquired (programming or systems development being an obvious example).

More general experience returns are estimated to be slightly lower in this study than comparable studies. This may be due to this study being able to specifically identify computer experience, thereby lowering the coefficient on the potential experience variable. Coefficients on the age of the youngest child variable are positive for younger children, and negative for older children (the comparison group is for employees without children). This surprising result is largely due to institutional structures in Australia, where a premium is paid to casual or part-time workers. As shown in Table 8, employees with children are slightly more likely than employees without children to work casually or part-time. Given the high cost of child care, it is likely that a woman with young children's reservation wage per hour is higher than women without children. Hence, under these conditions, the coefficient on younger children's wages would be positive and, older children negative.

Having determined the differential returns to various computer skills for men and women, it is possible to determine the degree to which women are 'undervalued' by employers who utilise information technology skills of their employees. To do this, we follow the methodology identified by Oaxaca (1973).[8] In this approach, we can predict the change in women's wages which would be associated with remuneration of skills based upon the rate of male remuneration.

**Table 8.** Percentage of full- and part-time employees with young children

| | Age of youngest child (yrs) | | | | | |
|---|---|---|---|---|---|---|
| | 0–2 | 3–4 | 5–9 | 10–14 | No child | Total |
| FT casual | 4.31 | 5.38 | 3.17 | 3.56 | 5.66 | 5.07 |
| PT casual | 13.77 | 17.98 | 18.62 | 15.71 | 14.00 | 14.79 |
| FT permanent | 70.54 | 64.37 | 63.63 | 65.21 | 72.65 | 70.45 |
| PT permanent | 11.38 | 12.27 | 14.58 | 15.53 | 7.69 | 9.69 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 9.** Wage effect of differential returns and level of computer skills to males and females

| **Decomposition factor** | **Wage effect (%)** |
|---|---|
| Unexplained differences, $(\alpha_m - \alpha_f)$ | 57.83 |
| Differences in the wage returns to various human capital skills and attributes, $X_f(\beta_m + \beta_f)$ | 31.23 |
| Differences in the human capital skills and attributes returns, $\beta_m(X_m - X_f)$ | 21.43 |
| Differences in the returns to various computer skills between men and women, $C_f(\chi_m + \chi_f)$ | − 13.39 |
| Differences in the level of computer skills between men and women, $\chi_m(C_m - C_f)$ | 2.88 |
| Total effect | 100 |

Hence, from the earning function:

$\ln W_i = \alpha_i + \beta_i X_i + \chi_i C_i + e$ for i = males, females

it is possible to adopt the following decomposition as described by Oaxaca (1973):

$$\ln W_m - \ln W_f = (\alpha_m - \alpha_f) + X_f(\beta_m + \beta_f) + \beta_m(X_m - X_f) + C_f(\chi_m + \chi_f) + \chi_m(C_m - C_f) + e$$

From this decomposition, the differences in male and female wages $(\ln W_m - \ln W_f)$ can be decomposed into:

- unexplained differences, $(\alpha_m - \alpha_f)$;
- differences in the wage returns to various human capital skills and attributes, $X_f(\beta_m + \beta_f)$;
- differences in the human capital skills and attributes returns, $\beta_m(X_m - X_f)$;
- differences in the returns to various computer skills between men and women, $C_f(\chi_f + \chi_f)$; and
- differences in the level of computer skills between men and women, $\chi_m(C_m - C_f)$.

Using the results from Table 9, and applying the above decomposition it can be seen that differences in the returns to computing skills decreases the wage differences between males and females by 13.4%. The differences in the level of computing skills accounts for 2.9% of the wage difference between men and women. In other words, if females were paid to use information technology skills at the same rate as males (after accounting for all other measurable factors) then they would receive a 13.4% reduction in their wage. Additionally, the value of providing females with computing skills comparable to males is estimated increase their wages by only 2.9%.

## Section IV: Conclusions

This article has demonstrated that it is not computer skills *per se*, which are rewarded in the labour market in Australia, but rewards are dependent upon the type of usage undertaken. The magnitude of the wage effect for each computer use ranges from zero (for word processing) to 6.2% (for specialist packages). It is important to bear in mind that each of these effects is additive. Hence, an individual with several types of computer usage will, on average, benefit to the sum of each of the coefficients. For example, an individual who utilises word processing, data bases and spreadsheet is likely to experience a wage increase of between 10.7% and 13.8%. Thus, for individuals with generalised computer experience, the wage premium is similar to the effect attributed to high levels of formal educational attainment. The estimated wage equations illustrate the importance of the inclusion of computer experience in the specification of the model, with bias on educational variable exceeding 50% when these variables are omitted.

Several implications for training strategies arise from these results. Firstly, the results indicate that use of computers provides significant wage benefits. Individuals who use computers in one form appear likely to have more general computer experience. Hence, rather than adopt training strategies to increase the number of computers skills an individual can acquire, it would appear basic computer literacy should be a primary objective.

Secondly, the magnitude of the effects of computer skills on wages indicate that for individuals unlikely to successfully complete higher levels of formal education, post secondary school computer training would significantly increase the wage premium an individual could attract.

Whilst some types of computer uses are specifically associated with certain occupations (such as computer programming skills), formal qualifications are not always prerequisites. Hence, for many individuals, on the job experience in areas requiring these specialist skills would be a significant asset.

Finally, this study has identified the potential role computer skills have in reducing the wage differences observed between males and females. For both males and females, the ability to utilise these technologies is as important in human capital accumulation as English proficiency and some formal education qualifications. The effect of computer skills on wages was more important for females than males. Indeed, the results suggest that computer skills possessed by females are rewarded at a rate higher than equivalent skills possessed by males. It is estimated that if males and females were equally rewarded for their computer skills, the gender wage differential between males and females would increase by 13.4%.

## Notes and References

1. Australian Bureau of Statistics (ABS), *Information Technology (preliminary)*, Australia, 1997, Catalogue No. 8143.0.
2. Alan B. Krueger, 'How computers have changed the wage structure: evidence from microdata, 1984–1989', *Quarterly Journal of Economics*, 106, 1993, p. 34.
3. For further information on this effect see D.S. Hamermesh and A. Rees, *The Economics of Work and Pay*, Harper and Row, New York, 1988.
4. Details of the questionnaire and responses from this survey can be found in Australian Bureau of Statistics *Training and Education Experience Australia 1993: Sample File on Magnetic Media*, Australian Government Publishing Service, Canberra, 1994, Catalogue No. 6274.0.
5. Summary statistics on the data used in this paper are available from the author (email: Anne.Hawke@flinders.edu.au).
6. Paul Miller and Charles Mulvey 'Computer Usage and Wages in the Australian Labour Market', Discussion Paper 96/6, The Centre for Labour Market Research, 1996.
7. The full specification may be obtained from the author (email: Anne.Hawke@flinders.edu.au).
8. Ronald Oaxaca, 'Male-female wage differentials in urban labor markets', *International Economic Review*, 14, 3, 1973, pp. 693–709.