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Sources of the Gender Wage Gap in a New Zealand Birth Cohort

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Abstract

The gender wage gap is a well-established finding that has been observed in a range of different societies. This paper examined the sources and composition of the gender wage gap in a New Zealand birth cohort of 30 year-olds. Prior to adjustment for explanatory variables, male wages were 38.0 per cent higher than female wages. After adjustment for human capital endowments, job characteristics and family responsibilities, there remained an unexplained gender wage gap of 11.5 per cent. Decomposition of the gender wage gap revealed that 66.4 per cent of the total gender wage gap could be explained by gender differences in human capital, job characteristics and family factors. These results suggest that, even after accounting for gender differences in a wide range of explanatory variables, males continue to earn significantly higher wages than females.

1. Introduction

One of the more well-established findings of labour economics is that women tend to earn less then men (for examples, see Joshi and Paci 1998; Stanley and Jarrell 1999; Blau and Kahn 2000; Weichselbaumer and Winter-Ebmer 2005). This gender gap in wages has been reported in a range of different countries and has been the subject of substantial theorising and debate (Dixon 2000; Drolet 2001; Siphambe and Thokweng-Bakwena 2001; Kidd and Shannon 2002; Rubery *et al*., 2005; Weichselbaumer and Winter-Ebmer 2005; Daly *et al*., 2006).

Broadly speaking there are two general explanations of the gender wage gap. The first set of explanations centres around gender differences in the levels of work-related and non-work-related factors including: education; hours worked; employment history; job experience; commitments to parenting; and other such factors. These explanations share the common theme that gender differences in wages are explained by gender differences in life circumstances, choices and career trajectories. They

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imply that men and women have different wages because of gender-related factors that influence the nature and extent of participation in paid employment. However, an alternative and more subtle explanation of the gender wage gap is that gender differences in wages arise because women with identical characteristics and circumstances to men nonetheless earn lower wages than men. In contrast to the first explanation which focuses on the role of gender differences in life circumstances, choices and career trajectories, this second explanation suggests the presence of discriminatory practices within the labour market that either mitigate against female wages or promote male wages.

The ways in which these different factors contribute to the gender wage gap is addressed by the Oaxaca-Blinder decomposition technique (Blinder 1973; Oaxaca 1973), which is described in detail in section two of this paper. For the most part, previous studies that have examined the gender wage gap using the Oaxaca-Blinder decomposition method have reported that a substantial proportion of the gender wage gap can be explained by gender differences in human capital characteristics, job characteristics, and family responsibilities, although a smaller unexplained gender gap remains even after accounting for gender differences in these factors (for example, see O'Neill 2003; Blau and Kahn 2007; Joshi *et al*., 2007, see section two for discussion of previous studies). However, it is not clear to what extent the results of these studies generalise to the New Zealand context. Few previous studies have used the Oaxaca-Blinder decomposition method to examine the gender wage gap in New Zealand, and the few studies that have done so have had limitations. Specifically, previous New Zealand studies have used samples that are not representative of the general New Zealand labour market, have used imputed measures of work experience, and have used wage measures from the late 1990s, since which time there have been changes in the characteristics of individuals entering the New Zealand labour market (see section two for a detailed discussion of previous New Zealand research and its limitations).

This paper addresses this lack of New Zealand research by examining the gender wage gap in a New Zealand birth cohort born in Christchurch in 1977 and followed for 30 years. It avoids the limitations of pervious studies by: i) using recent wage data from a relatively young cohort of individuals who are employed in a range of areas across the New Zealand labour market; and ii) using detailed longitudinal data which include a range of measures that may explain the gender wage gap, including educational achievement, work experience, job characteristics, and family responsibilities.

The remainder of this paper is split into five sections. Section two describes the theoretical background to models of the gender wage gap and the Oaxaca-Blinder decomposition, and outlines key findings from previous studies that have used the Oaxaca-Blinder decomposition method to study gender wage gaps, with a focus on studies from New Zealand. Section three describes the sample and methods used in the current study. Section four presents the results from the wage specification and the Oaxaca-Blinder decomposition. Section five discusses the results and draws conclusions.

2. Background

Theory and Decomposition of Gender Wage Gaps

Human capital theory states that wages are a form of financial return on an employee's

job-relevant knowledge and skills. Wages can therefore be modelled using a human capital wage specification, in which log wages are modelled as a function of human capital characteristics (including measures of knowledge and skills) and an error term. In general, this model is

$$LnY_i = \beta_0 + \sum\beta_j Z_{ij} + U_i \quad (1)$$

where LnY_i is the natural log of weekly wages from paid employment for individual i, Z_{ij} are the human capital characteristics (j=1…n), and U_i is the disturbance term. While the human capital characteristics included in the model typically include education and job experience, the wage specification frequently includes other factors that are not measures of human capital. This is especially true in studies that model gender differences in wages, where the model is often extended to include factors such as job characteristics (occupation, industry, hours worked), and family responsibilities (parenthood and number of children).

The ways in which different factors contribute to the gender wage gap has been most clearly addressed by the Oaxaca-Blinder decomposition technique (Blinder 1973; Oaxaca 1973). This technique was outlined in 1973 in two papers by Oaxaca (Oaxaca 1973) and Blinder (Blinder 1973) and has since become the standard method for examining the gender wage gap. The Oaxaca-Blinder decomposition technique uses the coefficients from the human capital wage specification outlined in equation 1 to decompose the gender wage gap into the proportion accounted for by differences in mean characteristics, and the proportion accounted for by differences in the returns to those characteristics. The decomposition model assumes that the wages earned by males and females are determined by gender-specific wage specifications of the form

$$LnY_i^M = \beta_0^M + \sum\beta_j^M Z_{ij}^M + U_i \quad (2)$$

$$LnY_i^F = \beta_0^F + \sum\beta_j^F Z_{ij}^F + U_i \quad (3)$$

where LnYi is the natural log of weekly wages from paid employment for individual i, Z_{ij} are relevant human capital, job and family characteristics (j=1…n), Ui is the disturbance term, and the superscripts M and F indicate that the models apply to males and females respectively. The Oaxaca-Blinder decomposition follows directly from equations 2 and 3 and is given by

$$(LnY^M - LnY^F) = \sum(X_j^M - X_j^F)\beta_j^M + [\sum(\beta_j^M - \beta_j^F)\, X_j^F + (\beta_0^M - \beta_0^F)] \quad (4)$$

Equation 4 represents the gender wage gap as a weighted function of:

a) Gender differences in the means of the independent variables $X_1 \ldots X_n$
b) Gender differences in the regression parameters $\beta_0 \ldots \beta_n$

The first part of the decomposition represents the component of the gender wage gap that is explained by gender differences in the characteristics of males and

females, while the second part of the decomposition represents the component of the gender wage gap that is explained by gender differences in the rewards received by males and females with equal characteristics.

Adjustment for selection into paid employment

Selection bias can arise in studies of the gender wage gap due to the fact that it is only possible to observe wages for those individuals in paid employment. In theory, the decision to enter paid employment is based on a comparison of the wages an individual could expect to receive in paid employment with the 'reservation wage' that they could expect to receive if they did not enter paid employment. When wage offers for paid employment are higher than the reservation wage, it is likely that individuals will enter paid employment. Conversely, when wage offers for paid employment are lower than the reservation wage, it is unlikely that individuals will enter paid employment. Therefore, there are likely to be systematic differences between the wage offers of those in paid employment and those who are not in paid employment, with those in paid employment having higher wage offers than those not in paid employment. This may be especially true for women, where difficulties associated with balancing work and family roles may mean that women will not enter paid employment unless the difference between the reservation wage and the employed wage is particularly large.

In order to account for this sample selection bias it has become common practice in wage specifications to adjust wages for selection bias. This can be achieved by using Heckman's (1979) two step procedure in which the probability of participating in paid employment is calculated and then included as an independent variable in the wage model. While adjustment for selection bias has become standard practice in studies of the gender wage gap, the approach has been criticised by some authors (for review, see Puhani, 2000).

Previous Findings from Oaxaca-Blinder Decomposition Studies

There is a large body of literature that has examined the extent to which different factors contribute to the gender wage gap. For the most part, this literature has identified three types of factors as being important: human capital characteristics such as education, work history, and job experience; job characteristics such as occupation, hours worked, and industry; and family responsibilities such as being the primary caregiver for dependent children, and being a sole parent.

For example, an analysis of the gender wage gap in two United Kingdom birth cohorts by Joshi and Paci (1998) revealed a total gender wage gap of 40.1 per cent of the female wage. Gender differences in human capital, job characteristics, and parenthood together accounted for 23.9 percentage points of the gap, leaving an unexplained gap of 13.1 per cent of the female wage. The addition of job characteristics to the model made the single largest reduction in the unexplained gender wage gap. Including human capital characteristics and parenthood in the model resulted in only small further reductions in the unexplained portion of the gender gap.

A study by O'Neill (2003) decomposed the gender wage gap in the National Longitudinal Survey of Youth (NLSY) cohort from the United States, and revealed an unadjusted gender log wage gap of 27.9 per cent, of which 24.7 percentage points

could be explained by gender differences in education, work experience, occupation, job characteristics and factors related to parenting (O'Neill, 2003). After adjustment for these factors, the gender wage gap in the NLSY was reduced to 2.6 per cent.

Studies using panel or census data have also reported that much of the gender wage gap can be explained by gender differences in personal characteristics, job characteristics, and family responsibilities. For example, Blau and Kahn (2007), using the Panel Study of Income Dynamics in the United States, reported a total gender wage gap of 20.3 per cent in 1998, which was reduced to 8.3 per cent after adjustment for educational achievement, work experience, occupation, industry, union status, and race. The largest contributors to the gender wage gap were occupation and industry, which together explained 49.3 per cent of the total gender wage gap. A study from Canada (Drolet, 2001) using data from the Survey of Labour and Income Dynamics found a total gender wage gap of 19.7 per cent, of which approximately one third to one half could be explained by gender differences in education, experience, tenure, family responsibilities, industry, occupation, and other factors. Again, industry and occupation made the largest contribution to the gender wage gap, accounting for 19.8 per cent of the total gap, with experience also accounting for a substantial proportion (10.1 per cent) of the gap.

Studies of changes in the gender wage gap over time have revealed that the size of the unadjusted gender wage gap has decreased over the last two decades. In the United States, Blau and Kahn (2006) have reported that the size of the gender wage gap declined rapidly during the 1980s, from a female to male pay ratio of .63 in 1979 to .75 in 1989, and then declined more slowly during the 1990s, reaching .80 by 1998. This reduction in the gender wage gap was caused by a number of factors, including: an increase in women's work experience relative to men; changes in male and female occupational structures; deunionisation; and a decrease in the 'unexplained' component of the gender wage gap (Blau and Kahn, 2006; Blau and Kahn, 2007). Projections of the future wage gap in the United States (Shannon and Kidd, 2003) and in Australia (Kidd and Shannon, 2002) have predicted that further increases in female educational achievement will continue to narrow the gender wage gap, but a small gender wage gap in favour of males will still remain in 2031 in Australia and 2040 in the United States.

The Gender Wage Gap in New Zealand

In New Zealand, as in many other countries, there is a gender wage gap in favour of males. This gender wage gap in New Zealand has decreased over the last two decades, with Dixon (2000; 2004) reporting that the gender gap in hourly wages narrowed significantly during the 1980s and 1990s, from a gap of 21 per cent of the male wage in 1984 to 14 per cent of the male wage in 1999. However, recent statistics indicate that females continue to earn lower wages than males, both in terms of hourly and weekly earnings. The June 2008 round of the New Zealand Income Survey (a survey of individuals from a random sample of approximately 15,000 New Zealand households) reported a gender gap in hourly wages of 14.9 per cent of the male wage, while the gap in weekly wages for all those in paid employment was 24.3 per cent of the male wage (Statistics New Zealand, 2008).

Only a few previous studies have used the Oaxaca-Blinder decomposition to

examine the extent to which various factors contribute to the gender wage gap in New Zealand. One recent example is a study conducted by Dixon (2000), which examined the gender wage gap in New Zealand using data from the New Zealand Income Survey (described above) and the Household Economic Survey, a sample of more than 7000 individuals from New Zealand households. Dixon reported that, at the end of the 1990s, there was a total gender wage gap of approximately 14 to 19 per cent of the male wage. Gender differences in education, experience, industry, and occupation together explained between 40 and 80 per cent of this total gender wage gap, leaving an unexplained gender wage gap of 2.7 to 7.1 per cent of the male wage. Occupation, industry and experience made the largest contributions to the total gender wage gap.

Another two recent New Zealand studies used the Oaxaca-Blinder decomposition method to examine the gender wage gap in the New Zealand public service (Gosse, 2002; Gosse and Ganesh, 2004). These studies reported a gender wage gap amongst public service employees of 15.5 per cent of the male wage. Gender differences in human capital (age, tenure, ethnicity) and employment characteristics (occupation, employer, region, employment term and employment agreement) accounted for 70.0 per cent of the gender wage gap, leaving an unexplained gender wage gap of 4.7 per cent of the male wage (Gosse, 2002). A further study reported that the addition of job size, a measure of job seniority, to the model further reduced the gender gap and resulted in an unexplained gender wage gap of only 1.1 per cent (Gosse and Ganesh, 2004).

However, these previous studies of the gender wage gap in New Zealand have some limitations. Gosse and Ganesh's studies (Gosse, 2002; Gosse and Ganesh, 2004) were restricted to individuals working in the New Zealand public service, and did not include individuals working in the private sector. As noted by Gosse (Gosse, 2002), the New Zealand public service has additional laws relating to employment equity that are not reflected in the private sector. Therefore, it is not clear to what extent Gosse and Ganesh's results apply to the wider New Zealand employment context. While Dixon's sample included individuals from across the New Zealand labour market, this study has two limitations. First, the study used imputed estimates of work experience as no measure of experience was available in the data set. Second, since the time that wages were recorded for Dixon's study (in 1998), there have been substantial changes in the relative levels of educational achievement of males and females entering the New Zealand labour market. Females in New Zealand are currently more likely than males to attain secondary school qualifications, attend university, and attain university degrees (Ministry of Education, 2006; Ministry of Education, 2007). These changes in the relative educational achievements of males and females may have consequences for labour market outcomes, but these consequences will only be apparent in samples of a younger age than that used by Dixon.

Against this background, this paper examined the gender wage gap in members of a New Zealand birth cohort studied to the age of 30. This paper has several advantages over previous studies of the gender wage gap in New Zealand. First, it used a birth cohort of individuals who were employed in a range of areas across the New Zealand labour market. Second, the relatively young age of the cohort provides an opportunity to examine the size of the gender wage gap in a cohort of individuals

where females have higher educational achievement and more qualifications than males (for studies of gender differences in educational achievement in this cohort, see Fergusson and Horwood, 1997; Gibb *et al*., 2008). Finally, the longitudinal design of the study means that detailed data are available on a range of measures that may explain the gender wage gap, including educational achievement, work experience, job characteristics, and family responsibilities. The specific aims of this study were:

1) To document the size of the gender wage gap for cohort members in paid employment at age 30;
2) To develop a model of the ways in which human capital factors, job-related factors, and family factors are related to wages;
3) To use the Oaxaca-Blinder decomposition to estimate the proportion of the gender wage gap that was attributable to gender differences in characteristics, and the proportion that was attributable to gender differences in the rewards for these characteristics.

3. Methods

Data Sources

Data were gathered as part of the Christchurch Health and Development Study (CHDS), a longitudinal study of a birth cohort of 1265 individuals born in Christchurch, New Zealand in mid-1977 and followed to age 30. The cohort has been followed up at birth, four months, one year, then at yearly intervals to age 16, and again at ages 18, 21, 25 and 30. Data were gathered using various methods including: structured interviews with participants and parents; teacher assessments; and standardised testing. The methodology and findings of the CHDS have been reviewed elsewhere (see Fergusson *et al*., 1989; Fergusson and Horwood, 2001).

Sample Size and Sample Bias

The sample used for this paper consisted of 785 of the original 1265 CHDS participants. This reduced sample size is due to two factors:

1) Over the course of the study there has been a gradual loss of participants due to participant refusal, inability to locate participants, and participant death. By age 30, the remaining sample consisted of 987 individuals, representing 78.0 per cent of the original sample.
2) The sample used for this paper was restricted to those in paid employment who did not have missing data for any of the explanatory variables. This sample consisted of 785 individuals, representing 79.5 per cent of the available sample at age 30.

In order to examine gender differences in wages, it was necessary to restrict the sample of participants to those who were working in paid employment (that is, receiving wages). However, those in paid employment may represent a selective sample with higher wage offers than those who are not in paid employment. This sample selection may bias observed wages upward, particularly for women. To correct for this

bias, wage estimates were adjusted for sample selection using methods described by Heckman (1979). For each individual, the probability of being in paid employment was calculated, based on the results of a logistic regression in which participation in paid employment (0=not employed, 1=employed) was modelled as a function of a series of factors that significantly predicted participation in fulltime employment. These factors were: number of dependent children; having a dependent child aged under five; being the primary caregiver for dependent children; months of fulltime employment in the last five years; months of part-time employment in the last five years; and hours spent in education or study per week. This probability estimate was then included as a covariate in the regression models.

Measures

For the purposes of the regression analyses reported in this paper, all variables except for wages and gender were centred around the mean.

Wages

At age 30, participants' current net personal weekly wages from all paid employment, after tax and other deductions, were recorded. Wages were recorded in continuous form to the nearest dollar. Participants who had variable weekly wages were asked to estimate an average weekly wage. Incomes in currencies other than New Zealand dollars were converted to New Zealand dollars using 2007 Purchasing Power Parity rates from the OECD (OECD, 2007). Wages in the analysis sample had a mean of $814.12 and a standard deviation of $643.00. The dependent variable used in the analysis was the natural log of weekly personal wages. This variable had a mean of 6.49 and a standard deviation of 0.69.

Predictor variables

A range of human capital measures, job characteristics, and measures of family responsibilities were included as predictor variables in the wage specifications. These variables are summarised in table 1, which describes each variable and reports the mean and standard deviation. More detailed explanations of the educational achievement and occupational status variables are provided below.

Educational achievement

At ages 18, 21, 25 and 30, participants were questioned about their history of educational achievement at school and in tertiary education (a description of the New Zealand school system can be found in appendix 1). These responses were used to construct a scale representing the highest level of educational attainment reached by age 30. This scale had seven levels, where '1' was no formal qualifications, '2' was one or more passes in School Certificate, '3' was attainment of Sixth Form Certificate, '4' was attainment of Higher School Certificate, '5' was attainment of University Bursary, '6' was attendance at university, and '7' was attainment of a Bachelors or higher degree from a university or equivalent tertiary education institution.

Consideration was also given to treating the educational achievement scale as a classification variable with seven levels. A test of linearity failed to detect any

nonlinear components in the relationship between educational achievement and wages ($F(5, 778)=1.99, p>.05$), and treating educational achievement as a classification variable made no substantive difference to the major conclusions of the analysis. Therefore, in the analyses reported in this paper, educational achievement was treated as a continuous scale ranging from one (no qualifications) to seven (university degree).

Occupational Status

The occupational status of the participant's main job was coded using the New Zealand Socioeconomic Index 1996 (NZSEI) framework (Davis et al., 2003). This classification assigns occupations a score between 1 and 90 based on the socioeconomic status of the occupation. Higher scores indicate jobs with higher socioeconomic status.

Table 1 - Means and Standard Deviations for Variables Used in the Study

Variable	*Description*	*Mean*	*Standard Deviation*
Educational achievement	Highest level of educational achievement attained by age 30, 1=lowest, 7=highest	4.49	2.27
Hours worked	Total number of hours worked per week in all paid employment at age 30	40.6	12.5
Occupational status	Occupational status of main job, 1=lowest, 90=highest	51.4	17.1
Time in occupational field	Months working in current occupational field	77.7	48.3
Time in job	Months working in current job	34.8	33.8
History of fulltime work	Months working in fulltime employment since age 18	99.1	35.6
Number of children	Number of dependent children who reside for the majority of the time in participant's home and are cared for by participant	.53	.93
Gender	Sex, 1=male, 2=female	52.4% were male	
Primary caregiver for dependent children	Participants who are responsible for more than 50 per cent of total childcare time for a dependent child, 0=not primary caregiver, 1=primary caregiver	13.1% were primary caregiver	
Employed partner	Participants with cohabiting partner who is in paid employment, 0=no partner in paid employment, 1=partner in paid employment	58.9% had employed partner	
Educational achievement	Highest level of educational achievement attained by age 30, 1=lowest, 7=highest	4.49	2.27

Statistical Analysis

All statistical analyses were conducted using SAS 9.1. Regression models were fitted using ordinary least squares methods with the 'PROC GENMOD' procedure in SAS 9.1. The dependent variable in all regression analyses was the natural log of weekly net wages from paid employment. Log weekly net wage from paid employment was

modelled as a function of the series of relevant covariates nested within gender. The intercept was allowed to vary with gender. Each model was refined by constraining those parameters that did not vary significantly with gender (p>.05) to be equal (see Results for a more detailed model specification).

4. Results

Descriptive Statistics

Table 2 shows the mean log weekly wage for males and females, before and after adjustment for selection into paid employment. The table also shows the gender wage gap, in log units. In each case, the gender wage gap was tested for statistical significance using a t-test for independent means. The p-value for significance from this test is shown in the table. The table shows that males had significantly higher wages than females, both before and after adjustment for selection into paid employment (both p<.0001). Prior to adjustment for selection, the gender wage gap was .322 log units. In real dollar terms, this value corresponds to male wages being 38.0 per cent higher than female wages. After adjustment for selection into paid employment the gender wage gap was smaller at .214 log units. In real dollar terms, this value corresponds to male wages being 23.9 per cent higher than female wages.

Table 2 - Mean Log Wages for Males and Females, Before and After Adjustment for Selection

	Males	*Females*	*Gap*	*p*
Mean log weekly wage	6.642	6.320	.322	<.0001
Mean log weekly wage (adjusted for selection)	6.606	6.392	.214	<.0001

Table 2 indicated that males earned significantly higher wages than females, even after adjustment for selection into paid employment. However, males and females are likely to differ in a number of ways, including their levels of human capital, the characteristics of the jobs in which they work, and their family responsibilities. Table 3 shows the scores for males and females on a series of variables related to human capital endowment, job characteristics, and family commitments. Each gender difference was tested for statistical significance using a t-test for independent means (for the continuous variables: educational achievement, history of fulltime work, time in job, time in field, occupational status, hours worked, and number of children) or a chi-square test for independence (for the dichotomous variables: primary caregiver and employed partner). The table shows that, compared to males, females had significantly higher educational achievement (p<.0001), had shorter histories of fulltime work (p<.0001), had been in their current fields for a shorter time (p<.0001), worked fewer hours per week (p<.0001), had more dependent children (p<.04), were more likely to be the primary caregiver for dependent children (p<.0001), and were more likely to have an employed partner (p<.0003). Compared to males, females had also been in their current jobs for a shorter time, and worked in jobs with slightly higher occupational status, although these differences were not statistically significant (both p>.12).

Table 3 - Scores for Males and Females on a Series of Human Capital, Job-related and Family factors

	Males	*Females*	*p*
Human capital			
Mean (SD)[1] educational achievement	4.16 (2.23)	4.87 (2.21)	<.0001
Mean (SD) history of fulltime work (months)	109.1 (31.3)	88.1 (36.9)	<.0001
Mean (SD) time in job (months)	36.6 (35.3)	32.9 (32.2)	.13
Mean (SD) time in field (months)	84.7 (49.4)	69.9 (45.9)	<.0001
Job characteristics			
Mean (SD) NZSEI occupational status	50.7 (16.2)	52.2 (18.0)	.21
Mean (SD) hours worked	44.3 (11.3)	36.6 (12.5)	<.0001
Family factors			
Mean (SD) number of children	.46 (.87)	.60 (.98)	<.04
% primary caregiver for children	2.4	24.9	<.0001
% with employed partner	52.6	65.8	<.0003

[1] Values in parentheses are standard deviations.

Model Specification and Estimation

While table 2 indicated that males earn significantly higher wages than females, table 3 indicated that males and females differ significantly in terms of human capital endowments, job characteristics, and family commitments. Any or all of these gender differences may contribute to the gender wage gap. It is therefore necessary to adjust the gender wage gap reported in table 2 for the gender differences reported in table 3. To achieve this, log wages were modelled as a function of the series of explanatory variables reported in Table 3, nested within gender, and the probability of selection into fulltime employment. The model fitted was:

$$LnY_i = \beta_0^G + \beta_1^G S_i^G \Sigma \beta_j^G Z_{ij}^G + U_i$$

where LnY_i was the natural log of weekly wages from paid employment for individual i, S_i represented the probability of being in paid employment for individual i, Z_{ij} were the relevant explanatory variables, and U_i was the disturbance term. In this model, the superscript G denotes the parameter applies to the Gth gender group (G=M, F). The model was refined by constraining those parameters that did not vary significantly with gender ($p>.05$) to be equal for males and females. The difference between the male and female intercepts was tested for statistical significance using a Wald chi-square test.

Table 4 reports the adjusted regression parameters and standard errors from the refined model, and the value of R^2 for the model. The table shows that, even after controlling for the series of explanatory variables reported in table 3, there remained a significant gender difference in the intercepts of the wage functions ($p<.05$). The male intercept was 6.253, while the female intercept was 6.182. In real wage terms, this log wage gap of .071 corresponds to the male intercept being 7.4 per cent higher than the female intercept. Both of the job characteristic variables (hours worked and occupation), and most of the human capital variables (education, history of fulltime

work, time in field) were significant predictors in the model (p<.05). None of the family factors were significant predictors. There were significant gender differences in the parameters for hours worked (p<.008) and occupation (p<.007), and these parameters were allowed to vary with gender. All other parameters did not vary significantly with gender (all p>.22) and were constrained to be equal for males and females. The selection parameter was positive and significant, indicating the presence of a positive bias in selection into the labour market. The model had moderate to good prediction, explaining 60.4 per cent of the variance in log wages.

Table 4 - Regression Parameters (standard errors) from the Regression Model

	Males	*Females*
Intercept[a]	**6.253 (.130)**	**6.182 (.131)**
Human capital		
Education	**.063 (.009)**	**.063 (.009)**
History of fulltime work	**.003 (.001)**	**.003 (.001)**
Time in job	-.001 (.001)	-.001 (.001)
Time in field	**.001 (.000)**	**.001 (.000)**
Job characteristics		
Occupational status[b]	**.014 (.001)**	**.007 (.001)**
Hours worked[c]	**.023 (.002)**	**.030 (.002)**
Family factors		
Number of children	.005 (.021)	.005 (.021)
Primary caregiver	-.064 (.071)	-.064 (.071)
Employed partner	.037 (.033)	.037 (.033)
Probability of selection	**.320 (.142)**	**.320 (.142)**
R^2		.604

Note: Parameters in bold are significant at p<.05
[a] Test of gender difference in intercept was statistically significant (p<.05)
[b] Test of gender difference in hours worked parameters was statistically significant (p<.008)
[c] Test of gender difference in occupational status parameters was statistically significant (p<.007)

Oaxaca-Blinder Decomposition

Table 4 revealed that, even after adjustment for a range of explanatory variables related to human capital endowments, job characteristics and family factors, males continued to earn significantly higher wages than females. However, the analyses reported in table 4 provide no information about the relative proportions of the gender wage gap that can be attributed to differences in characteristics and differences in parameters. To examine this, the results of the regression analysis reported in table 4 were analysed using the Oaxaca-Blinder decomposition method (Blinder, 1973; Oaxaca, 1973, see section 1 for a detailed description of this method). This technique allowed the total log wage gap to be decomposed into two components: the component due to differences in mean characteristics; and the component due to differences in parameters. For the purposes of this paper, the parameter difference has been split into two components: the component due to differences in the parameters for the explanatory variables; and the component due to differences in intercept.

Table 5 reports the results of this decomposition. The table shows that, overall, 66.4 per cent of the log wage gap was accounted for by differences in characteristics. Job characteristics made the greatest contribution to this component, with gender differences in job characteristics accounting for 47.9 per cent of the total gender wage gap. Human capital factors and selection contributed 9.3 per cent and 6.5 per cent respectively to the overall gender gap, while gender differences in family factors contributed only 2.7 per cent. The remaining 33.6 per cent of the gender wage gap is accounted for by differences in parameters and differences in intercept. The intercept difference accounted for most of this remaining gap, contributing 22.0 per cent to the overall gender gap. The remaining parameter difference was accounted for by differences in the parameters for job characteristics, which contributed 11.6 per cent to the overall gender gap.

Table 5 - Results of Oaxaca-Blinder Decomposition of the Gender Wage Gap

Characteristics (%)	
Human capital	9.3
Job characteristics	47.9
Family factors	2.7
Selection	6.5
Total characteristic gap	66.4
Parameters (%)	
Explanatory variables	
Human capital	0.0
Job characteristics	11.6
Family factors	0.0
Selection	0.0
Intercept	22.0
Total parameter gap	33.6
Summary (log values)	
Total gap	.322
Characteristic gap	.214
Parameter gap	.038
Intercept gap	.071

Note: Individual values may not sum to total values due to rounding.

In summary, the total gender gap in log weekly wages in the CHDS was .322 log units. In real wage terms, this corresponds to male wages being 38.0 per cent higher than female wages. Overall, .214 of this gap was accounted for by differences in characteristics. The remainder of the gap was accounted for by differences in parameters and differences in intercept, which together accounted for .109 of the gap. Of this component, .038 was due to differences in parameters, while .071 was due to differences in intercept.

Alternative Model Specifications

There has been some debate within the literature regarding the inclusion of particular

variables in wage regression equations. In particular, there has been debate about the effects of including measures of selection bias (for review, see Puhani, 2000) and measures of occupation (for examples see Blau and Ferber, 1987; Gunderson, 1989) in wage equations. In order to examine the effects of including or excluding these variables on the wage decomposition, a series of three alternative model specifications were fitted. The first was a model in which the selection parameter was removed from the wage equation. The model was otherwise identical to the final model described previously. The second alternative model was a model in which occupation was represented as a classification variable with 94 categories, instead of the occupational status measure used in the previously described model. These categories were coded using the three-digit level of the Australia and New Zealand Standard Classification of Occupations (Australian Bureau of Statistics/Statistics New Zealand, 2006). The third alternative model was a model in which the occupation variable was removed entirely. Table 6 reports summary results from the Oaxaca-Blinder decomposition for each of these alternative models. The results from the decomposition of the original final model are also reported for comparison. The table shows the results of the decomposition were similar across the different model specifications. The component of the gender wage gap accounted for by gender differences in characteristics ranged from .201 log units to .220 log units, accounting for 62.4 to 68.3 per cent of the total gender wage gap. The component of the gender wage gap accounted for by gender differences in returns to characteristics ranged from .012 to .043, representing between 3.7 and 13.4 per cent of the total wage gap. The gender difference in intercepts ranged from .068 to .090, accounting for between 21.1 and 28.0 per cent of the total gender wage gap. Overall, the 'unexplained' portion of the gender wage gap (the intercept gap plus the parameter gap) accounted for between 31.7 and 37.6 per cent of the total gender wage gap.

Overall these results indicate that the findings from the wage decomposition were consistent across different model specifications. This suggests that the inclusion of variables for selection bias and occupation did not have a substantial impact on the results of the decomposition.

Table 6 - Comparison of Decomposition Results for Alternative Model Specifications

	Final Model	*No Selection*	*Occupation 94 Categories*	*No Occupation*
Characteristic gap	.214	.214	.220	.201
Parameter gap	.038	.040	.012	.043
Intercept gap	.071	.068	.090	.078

5. Discussion and Conclusions

This paper examined the sources and composition of the gender wage gap in a birth cohort of 30-year old individuals. The results revealed a total gender wage gap in this cohort of .322 log units, which in real wage terms corresponds to male wages being 38.0 per cent higher than female wages. However, there were significant differences between males and females in terms of their human capital endowments, job characteristics,

and family responsibilities. The results of an Oaxaca-Blinder decomposition revealed that approximately two-thirds (66.4 per cent) of the total gender wage gap could be accounted for by gender differences in these characteristics. The remainder of the gap was due to differences in parameters, which accounted for 11.6 per cent, and the intercept difference, which accounted for 22.0 per cent. After adjustment for human capital measures, job characteristics, and family responsibilities there remained an unexplained gender wage gap of .109 log units, which in real wage terms corresponds to male wages being 11.5 per cent higher than female wages.

The finding that a gender wage gap remains even after adjustment for a range of human capital measures, job characteristics, and family responsibilities is consistent with the findings of Dixon (Dixon, 2000) who reported that an unexplained gender wage gap of up to 7 per cent remained after adjustment for human capital measures and job characteristics. However, they contrast with the findings of Gosse and Ganesh (Gosse, 2002; Gosse and Ganesh, 2004), who reported only a very small gender wage gap of 1.1 per cent after adjustment for human capital and employment characteristics. One possible explanation for this difference may be that Gosse and Ganesh's wage specifications included a variable that measured job seniority. Adding this job seniority variable to the model reduced the unexplained gender wage gap from 3.3 per cent to 1.1 per cent.

The proportion of the gap accounted for by characteristics in this study reflects the differences between males and females in their life circumstances, choices and career trajectories. In this study, most of the characteristic gap was accounted for by job-related factors, specifically, the number of hours worked per week and the occupational status of the job. Human capital factors and the probability of selection into the workforce made small contributions towards the explained component of the gap, while the contribution of family factors was negligible. The negligible contribution made by family factors is consistent with previous studies which have indicated that family factors contribute little to the overall gender wage gap when human capital and other characteristics are controlled for (Marini and Fan, 1997; Joshi and Paci, 1998).

The proportion of the gap that is explained by differences in parameters and differences in intercept is generally labelled the 'unexplained' component of the gender wage gap (for discussion, see Blau, 1998). The unexplained wage gap in this cohort was .109 log units, which in real wage terms corresponds to male wages being 11.5 per cent higher than female wages after differences in characteristics are taken into account. The greatest contribution to the unexplained gap came from the intercept difference, with a smaller contribution coming from the parameters for hours worked and occupational status. There are at least two possibilities that may account for the unexplained proportion of the gap. The first is that the unexplained gap reflects the presence of gender discrimination in the labour market, with women receiving lower wages than men for the same characteristics. However, an alternative possibility is that the unexplained gap is the result of additional explanatory factors that have not been controlled for in the analysis. While efforts have been made to control for a wide range of human capital, job-related and family factors, it remains possible that additional explanatory variables exist which have not been controlled for.

It is interesting to note that a gender wage gap exists in the CHDS despite

the fact that females have substantially higher levels of educational achievement than males in this cohort (Fergusson and Horwood, 1997; Gibb *et al*., 2008). This suggests that further increases in female educational achievement relative to males will likely have little impact on the gender wage gap in New Zealand.

An advantage of this study was that it used data from a contemporary cohort of individuals whose human capital characteristics and job preferences are likely to be representative of individuals entering the New Zealand labour market currently and in the near future. Furthermore, the longitudinal nature of the data set provided a rich source of information on human capital characteristics and family factors. Information of this depth is not often available from panel studies or census data. However, a limitation of this study is that it relates to a cohort of individuals born in a particular place (Christchurch, New Zealand). It is unclear to what extent these results will generalise to other cohorts of individuals born in different places, in which the labour market conditions may be substantially different.

Nonetheless, the results of the current study indicate that, even after extensive adjustment for a range of human capital, job-related and family-related explanatory factors, there remains an unexplained gender wage gap in the CHDS, with men receiving wages that are 11.5 per cent greater than those received by women with identical characteristics.

Appendix 1

Description of the New Zealand School System

Students in New Zealand attend primary school for eight years (Year 1-Year 8) and high school for a maximum of five years (Year 9-Year 13). The minimum school leaving age is 16. Most students turn 16 in Year 11, however, the majority of students remain at school until at least the end of Year 12. During the time that the CHDS cohort attended high school, the following qualifications were available. At the end of Year 11 students were eligible (but not required) to sit School Certificate examinations. Most students sat School Certificate examinations in four to six subjects. A grade of 'C' or higher was required to pass a subject. During Year 12, students who studied and passed an approved course (usually in five or six subjects) were awarded Sixth Form Certificate. Those students who had satisfactorily completed five fulltime years of high school education, including at least three courses above Sixth Form Certificate level, were awarded Higher School Certificate. In Year 13 students who were intending to attend university could sit University Bursary examinations. Most students sat University Bursary in five subjects. Students were awarded a grade between 1 and 100 for each subject. The grades for a student's best five subjects were summed to provide a total Bursary score. Those with total scores over 250 were considered to have passed University Bursary and qualified for additional financial assistance upon enrolment to University. Students in New Zealand have a range of choices for tertiary education, including universities, polytechnics, and private tertiary education providers. All universities and some polytechnics in New Zealand offer Bachelors degree courses which take a minimum of three years' full-time study to complete.

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