Wage Gaps in New Zealand in the Late 90's

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Abstract

Using data from New Zealand's annual Income Survey 1997-2000, we estimate wage regressions by two methods (Heckman and Maximum Likelihood) that take account of sample selection bias arising from the exclusion of individuals with no market income. Controlling for a set of productivity characteristics, we find evidence of significant and persistent positive differentials for males and individuals of European descent. Female discrimination is marked and consistent over all years. Evidence in the case of indigenous people (Maori) is more mixed with discrimination against other non-European ethnicities, especially Pacific Peoples, stronger.

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1. Introduction

New Zealand, a small and geographically isolated developed nation, provides an interesting context for the study of labour market discrimination in both the gender and ethnic dimensions. New Zealand was the first nation state in the world to grant women the right to vote in parliamentary elections, was an early adopter of equal pay legislation and is currently notable for having women filling the positions of Prime Minister, Governor General (Head of State), Chief Justice and Attorney General. New Zealand also has, in contrast to a number of other developed nations with a British colonial background, such as Australia, Canada and the United States, quite a large minority population who claim indigenous origin. The indigenous people are a Polynesian group known as Maori. According to the 2001 census, people claiming sole Maori ethnicity make up about 7.9% of the population. There are two other minority populations of significant size, Pacific Peoples (4.5%) and Asians (5.7%) with the vast majority of the population claiming European ethnicity.

For the majority of any people, economic status is derived from paid employment and health status may, to a large degree, depend on economic factors, as well might the educational opportunities of the next generation. It would therefore seem that labour market status is central to understanding the relative position of any group. A more complete picture emerges if we go beyond qualitative labour market status to consider wage rates. In doing so, one would attempt to hold constant some set of productivity characteristics in order to determine the effect of observationally distinct factors such as gender or ethnicity on wages. On the basis of the maintained hypothesis that there is neither gender nor ethnic discrimination in the labour market, wage differences between any two observationally distinct groups ought to be explainable in terms of variables such as age, experience, location and educational attainment. However, there is a potential problem with drawing conclusions about discrimination on the basis of studying wages. The sample used excludes those who have no market income, which may cause what is known as sample selection bias. Heckman (1979) was the first to develop a procedure to correct the sample selection bias inherent in ordinary least squares (OLS). Here, we use both Heckman's two-step approach, known as Heckit, and the maximum likelihood method (MLE) to estimate wage and participation equations simultaneously, to correct for sample selection bias.

We use unit record data from the Income Survey (IS) of Statistics New Zealand, which since 1997 has been conducted as an annual supplement to the quarterly Household Labour Force Survey (HLFS) in each June quarter. We have access to data from both surveys for the years 1997 to 2000 inclusive.

We find statistically significant evidence of a gender wage differential in favour of males in all four years of the study. We also find that individuals of both Pacific Islands and Asian origin consistently fare less well than do those of European extraction, while the picture that emerges of New Zealand's indigenous population (Maori) is more conflicting.

The outline of the remainder of this paper is as follows. In Section 2 we give some background information on New Zealand society that is needed to place our results in context. In Section 3 we define economic discrimination and explain how it can be measured. Section 4 briefly examines previous evidence, while Section 5 discusses the data set used. The econometric models are outlined in Section 6. Section 7 presents the results, which provide clear evidence of economic discrimination on both gender and ethnic bases. Section 8 concludes and sets out a future research agenda.

2. New Zealand society

New Zealand is the last country in the world to have become inhabited by a human population. There is archaeological evidence to indicate that Maori settlement was well established by the thirteenth century A.D. but, in the absence of written history from this period, estimates of the timing of human settlement vary widely. Belich (1996:36) suggests the eleventh century as a reasonable estimate, while Sinclair (2000:14) prefers the eighth. Whatever the details of the timing, prior to the arrival of Europeans, the indigenous inhabitants had no concept of ethnicity or race. The word Maori simply means ordinary people to distinguish them from the new arrivals, whom they dubbed Pakeha.

The first European discoverer was the Dutchman Abel Tasman in 1642. British explorer James Cook took possession of the country for the British Crown in 1769 but it was not until 1839 that William Hobson established British rule as a dependency of the colony of New South Wales, following the formation in 1837 in London of the New Zealand Association with the aim of colonisation. British sovereignty was proclaimed and the Treaty of Waitangi signed between the British Crown and a number of Maori Chiefs on 6 February 1840 (Sinclair 2000:72). This treaty ceded sovereignty to the British Crown, while affording Maori the protection of the Crown and "the unqualified exercise of their chieftainship over their lands, villages and all their treasures" (State Services Commission 2003). Even this brief quote from the Treaty in its modern English translation raises the possibilities for differing interpretations and the original document was in two versions, one Maori and the other English.

Settlers, overwhelmingly from the British Isles, extensively colonised the country in the years following the signing of the Treaty (King 1997:29). Serious conflict between British settlers and Maori soon followed with Maori Wars in the 1840s (Sinclair 2000:79) and 1860s (Belich 1996:210-211). Maori were quick to adopt Pakeha technology in these conflicts and Belich (1996:235-241) credits them with the invention of modern trench warfare in adapting their traditional fortified villages (Pa) to very effectively resist attack. Armed resistance to colonisation did not cease until 1872.

During the first half of the twentieth century Maori and Pakeha populations remained largely geographically separated (King 1997:69) but from World War II onwards, Maori increasingly migrated to the cities, attracted by well-paid unskilled work, particularly in the economic boom times of the 1950s and 1960s. King (1997:88) notes that in 1936 only about 11% of the Maori population were urbanized but in the 1980s this proportion had risen to nearly 80%. This process left Maori vulnerable in times of economic downturn.

The last thirty years had been characterized by a renaissance of interest in Maori culture and language. In 1975 The Treaty of Waitangi Act established the Waitangi Tribunal to investigate Treaty grievances by Maori against the Crown. The Ministry of Maori Development (Te Puni Kokiri) was set up in 1992 with the specific aims "to improve outcomes for Maori and ensure the quality of government services delivered to Maori" (Te Puni Kokiri 2004a). This agency, in conjunction with Statistics New Zealand, maintains evidence highlighting the position of Maori relative to the rest of the population. These statistics tend to show Maori over-represented amongst the unemployed, the imprisoned and those on welfare and Maori youth faring less well in the education system (Te Puni Kokiri 2004b).

The position of Pacific Peoples in New Zealand to some extent mirrors the Maori migration to the cities, although the large-scale migrations of Pacific people to New Zealand started somewhat later, in the 1960s. In 2001, people claiming Pacific ethnicity made up 6.5% of New Zealand's population, with 58% of them born in New Zealand (Ministry of Pacific Island Affairs 2002:17). Treating this group as a whole hides considerable ethnic diversity. There are six major ethnic groups making up the New Zealand resident Pacific population (Samoan, Cook Islands, Tongan, Niuean, Tokelauan and Fijian) with a number of other smaller groups. However, to ensure reasonable sample sizes for many statistical purposes, including our analysis, Pacific Peoples are treated as one group. As such, they share with Maori an apparently economically disadvantaged position. For example, their median hourly earnings are about 85% of the national median and they are over-represented in the lower annual income bands (Ministry of Pacific Island Affairs 2002:108).

The other major ethnic classification reported by Statistics New Zealand (2003a) is "Asian". This classification, too, hides a great deal of ethnic diversity. In our analysis we use the category "Other" to refer to all those not identifying as European, Maori or Pacific. This classification largely amounts to the same as Asian. Migration of sizeable numbers of Asian people to New Zealand occurred in the 1990s. In particular, the highest rate of growth of any ethnic group between 1991 and 1996 was 71% amongst Asians (Statistics New Zealand 2003b). It is difficult to generalize about people from such diverse backgrounds, but some individuals, even amongst the highly qualified, have faced difficulties of access to the labour market.

In 1893, New Zealand was the first nation state in the world to grant the franchise to women. Nevertheless, the role of women in New Zealand society remained very much the traditional one prior to "the second wave of active feminism" in the 1970s (MacDonald 1993:161). As in other developed nations at that time, the Womens' Liberation movement centred on the issues of equal pay, the effects of gender stereotyping and the exploitation of female sexuality for commercial gain. The New Zealand Parliament enacted a number of pieces of legislation designed to address these issues, including the Equal Pay Act (1972), the Matrimonial Property Act (1976) and the Human Rights Commission Act (1977).

Thirty years on from this period of major activity, there is no doubt that the role of women in New Zealand society has changed markedly. This is particularly noticeable in political and public life. New Zealand ranks fourteenth equal in the world for the proportion of women in Parliament, with 28% of Members of Parliament at the 2002 election, with eight out of 26 Ministers of the Crown women and women holding all four key constitutional positions (Ministry of Women's Affairs 2002:48). Despite this apparent progress, there remain fairly evident gender differences, especially in the labour market. Female labour force participation, while increasing, remains lower than male labour force participation and female average earnings are about 84.3% of men's (Ministry of Women's Affairs 2002:73-76).

The documented gender or ethnic differential outcomes discussed above do not, of course, constitute conclusive evidence of any form of discrimination for reasons discussed in the next section.

3. Economic discrimination

Discrimination defies precise definition, but economic discrimination can be brought more clearly into focus by considering the question: "Under what conditions will essentially identical goods have different prices in competitive markets?" (Cain 1986:695). This

questions moves discrimination away from the labour market to any market but it is helpful in clarifying what we mean by economic discrimination. In the labour market, the goods are labour services and the prices are wage rates. By identical we mean that the goods (labour services) have the same productivity. The notion of productivity is here meant to entail the physical or material production process and does not involve any psychic utility of either employers or co-employees. It can, however, be taken to include various worker characteristics such as skill and dependability. There is a difficulty here. Such characteristics have the potential to raise productivity and, in the presence of discrimination, they may be partly endogenously determined. For example, an ethnic group's participation rate or willingness-to-produce may be conditioned on the group's experience of discrimination.

Neoclassical theories that rationalise the existence of different wage rates for equally productive but observationally distinct workers go back to Becker (1971, second edition of a work first published in 1957). They are almost entirely demand-side theories since it is assumed that all groups of workers have essentially the same tastes for work and, even if they are not equally productive, they at least have equal productive capacity. Becker (1971: 14) claims that if "an individual has a 'taste for discrimination', he must act as if he were willing to pay something, either directly or in the form of reduced income, to be associated with some persons instead of others." A number of different models then emerge, dependent on which agents are doing the discriminating: consumers, co-workers or employers. Since most goods do not require customer contact for their production, consumer-based discrimination is thought to play a minor role in differences in average wages across individuals having the same productive capacity, although it is certainly possible that consumer discrimination would lead to a certain amount of job segregation, particularly in the service industries.

Arrow (1973:10), in a version of a discrimination model in which it is the employers who discriminate, comes to the conclusion that, in the long-run, only "the least discriminatory firms survive." Even when (product market) monopolists can affect wages in the labour market (and it is my no means obvious that this is common) it is unlikely that they will persist in sacrificing profits by discriminating, since they would be open to a takeover by non-discriminating entrepreneurs.

Tests of hypotheses suggested by theories of economic discrimination are quite rare in the literature, principally because of the ambiguity of the models' predictions, most especially with regard to the length of the short and long runs. An added difficulty is that of matching theoretical variables with available empirical data. As it turns out, most work in this area takes the line of trying to measure the amount of discrimination by estimating, for example, the effect of race on wages, holding constant some set of productivity characteristics. Following the convention in the applied literature, we intend to estimate such as:

$$Y_i = X_i'\beta + \alpha Z_i + u_i \qquad (1)$$

Here, Y_i is the income, earnings or wages of the i^{th} person; X_i is a vector of productivity characteristics of the i^{th} person that are exogenous; Z_i is 1 if the person is in the "minority" group and 0 otherwise; u_i is a random error term; and α and β are vectors of coefficients.

One of the difficulties with the underlying model is that there is little agreement on which productivity variables are appropriate. No doubt we should consider whether the X_i are affected by labour market discrimination, but there is no obvious and simple way to decide on a variable's exogeneity. For example, years-of-schooling might be thought appropriate to hold constant if we believe that the decision to remain at or leave school is not influenced

by discrimination in the labour market. In practice, one has to make do with such data as are available.

Another difficulty relates to data censoring. Knieser, Padilla and Polachek (1978) consider this issue in detail. The most relevant issue here is the position of the unemployed, and how to treat market earnings of zero in the regressions. In the case of the wage distribution, an unemployed person is likely to have faced a wage offer that was less than his/her reservation wage, in the presence of social welfare benefits. Knieser, Padilla and Polachek show that an apparent improvement in the wage gap for Blacks in the United States is partly driven by the non-neutral racial effect of fluctuations in the unemployment rate. That is, the low earners amongst blacks tend to drop out of the sample.

Chay and Honore (1998) analyse the black-white male wage differential in the southern states of the US, conditional on the subjects' being employed. They argue that the black-white relative probabilities of being unemployed are very stable over the period of their study. Since their main interest lies in changes in discrimination over time, this allows them to treat observations censored at zero as randomly missing data. Given that our focus is on measuring discrimination at a point in time, although we do have four consecutive years of survey data available, we have the choice of studying the wage distribution conditional on being employed, or of finding a way to incorporate those with zero market income. The latter procedure is preferable, since it is clearly unreasonable to treat people who are not in employment as randomly missing when we know that there is considerable ethnic variation in employment status. (See the discussion of New Zealand evidence in Section 4 below.)

So, although the econometric procedures employed in estimating wage regressions of the form in (1) are straightforward, involving standard (OLS) estimation procedures with alternative dummy variable specifications, they are subject to what is known as the sample selection problem. Because we can only observe wages for working people, such estimations are based on truncated samples. This is, however, not a case of straightforward truncation; truncation is based on the outcome of another variable since people self-select employment. Whether or not we observe wage depends on an individual's decision to work or not. Because this decision may be systematically correlated to (potential) wage, the sample may have effectively been selected in a non-random fashion, which might lead to a so-called sample selection bias in the OLS estimator.

The source of the bias can easily be seen by writing the model in (1) as (where we now subsume all explanatory variables into the vector X_i):

$$Y_i = \begin{cases} X_i'\beta + u_i, & \text{if } X_i'\beta + u_i > 0 \\ 0 & \text{otherwise} \end{cases} . \qquad (2)$$

If, for example, u_i is assumed to be normally distributed with mean zero and variance σ^2, then the expected value of Y for individuals who are working is:
$E[Y/Y>0] = X\beta + \sigma f(z)/F(z)$, where f(z) is the standard normal probability density function, and F(z) is the cumulative standard normal density function. The quantity f(z)/F(z) is called the inverse Mills' ratio. Thus, using ordinary least squares only for observations where $Y_i>0$ incorrectly omits the inverse Mills' ratio, resulting in a specification error and hence biased estimates of the parameters.

The usual approach to account for sample selection bias is to model wages jointly with the decision to work and add an explicit selection equation, which is of the binary choice type.

The most common way of estimating this sample selectivity model is the easy-to-implement two-step procedure proposed by Heckman (1979), known as Heckit. His procedure involves first estimating the selection equation by using an ordinary probit model, using all observations. The parameter estimates are then used to estimate inverse Mills' ratios for observations in the selected sample. In the second step, the wage regression equation is estimated by ordinary least squares for the observations in the selected sample, with the estimated inverse Mills' ratio as an additional regressor. This results in consistent and asymptotically normal estimators of the parameters of the wage regression equation.

This two-step procedure is, in general, not efficient. An alternative method is full information maximum likelihood method, which produces consistent and asymptotically efficient estimators that have an asymptotic normal distribution. Although this is a more efficient estimation method, and therefore is superior to Heckit, it has not had that much use due to computational difficulties and the lack of capable software. In fact, even Heckman (1979) himself writes that the purpose of his estimator is only to "provide good starting values for maximum likelihood estimation" and "exploratory work", as pointed out by Puhani (2000). Here, we use both Heckit and MLE methods. The details of the models we use are set out in Section 6 below.

4. Previous evidence

Cain (1986:743) summarises many previous results, noting that they are extremely varied and "reveal as much about our ignorance as our knowledge". Overseas work in this area is more useful in formulating a framework for a New Zealand study than for comparing any particular measures of discrimination in themselves, but recently there has been resurgence of interest is re-evaluating labour market outcomes for both women and minority groups. Cawley, Heckman and Vytlacil (2001) confirm that wage payment still does vary by gender and race in the US. Bell and Ritchie (1998), Christofides, Li, Liu and Min (2003), Kidd and Ferko (2001) and Albrecht, Bjorklund and Vroman (2003) document the continuing gender differentials in the UK, Canada, Austalia and Sweden, respectively. All of these authors explicitly recognize the issue of sample selection bias. Blau and Kahn (2003) offer comparative international evidence on the gender pay gap across 22 countries.

Econometric evidence on discrimination specific to New Zealand is not particularly abundant. A series of papers throughout the 1980s, Brosnan (1982, 1984, 1985, 1987), Hicks and Brosnan (1982), Poot and Brosnan (1982), Brosnan and Hill (1984), Revell and Brosnan (1986) and Brosnan and Wilson (1989), uses unpublished tabulations from census data to chart a detailed descriptive picture. For example, Brosnan and Wilson (1989) present descriptive statistics to show that women, young people and Maori bear a disproportionate burden of unemployment in New Zealand and that unemployment is more inequitably distributed here than in the other countries of their study (Australia, Norway, the UK and the US). More recently, since access to unit record data from Statistics New Zealand has been relaxed, there has been some econometric work undertaken in this area, notably by Dixon (1996a, 1996b, 1998), Winkelmann and Winkelmann (1997), Kirkwood and Wigbout (1999), Winkelmann (1999), Chapple (2000) and Sutherland and Alexander (2002).

Winkelmann (1999) draws random samples of the male working-age population from the censuses of 1986, 1991 and 1996. Each individual is classified as in full-time employment, part-time employment, unemployed or not in the labour force. Multinomial logit models are estimated using this unit-record data, controlling for changes in socio-economic and demographic factors. Winkelmann identifies two potential contributors for the declining

labour market outcomes of Maori men which he observes from 1986 to 1996; namely an increase in the return to skill and changes in the sectoral composition of the workforce.

Winkelmann adopts the usual Statistics New Zealand hierarchical definition of ethnicity whereby any person giving Maori as one of the responses to the question about ethnicity is classified as Maori. Chapple and Rea (1998: 129) point out that if Statistics New Zealand's "rule was the equally arbitrary criteria (sic) that anyone who reported any non-Maori ethnic group was non-Maori, a stroke of the statistical pen would currently convert a quarter of the Maori ethnic group in the HLFS into non-Maori." This issue is taken up again when we consider our use of the data.

Winkelmann and Winkelmann (1997) also use the multinomial logit model, finding that the observed individual characteristics to be insufficient to explain all differences in labour force status, except in some years of their study for women. They note a very high premium on qualifications for Maori and raise the issue as to whether University-educated Maori are a 'self-selected' group of higher than usual ability for graduates as a whole. This could be bound up with their facing additional obstacles to achieving a high standard of education or with the definition of ethnicity already discussed.

Kirkwood and Wigbout (1999) set out to explore the gender income gap. They use data from the HLFS supplemented by the IS to apply "tree analysis" to identify sub-groups of the sample each with their own unique characteristics which explain the differing levels of average weekly earnings. At each branch of the tree analysis, the algorithm used (Ghosh and Phillips 1998) finds the variable and the associated threshold point of that variable which best discriminates between high and low earners. As it turns out, the most significant factors are occupation, hours worked, age and highest qualification, with gender a distant fifth in importance and ethnicity not rating at all in the tree analysis.

Dixon (1998), in an update of her earlier work (Dixon 1996a, 1996b), uses Household Economic Survey (HES) data to model the log of real hourly earnings as a function of gender, age, education and ethnicity. Dixon finds no significant difference between Maori and non-Maori, but does raise the issues of the small sample size of the HES and the possibility of systematic measurement bias in the survey, for which she presents some evidence related to the idea that low earners tend to under-report hours worked and high earners over-report.

Chapple (2000) uses various data sources and socio-economic outcomes and reaches the conclusion that being Maori has a very low predictive power for socio-economic success or failure. He argues against using the first moments of distributions and advocates the use of other moments such as mode and variance. His conclusion that ethnicity does not matter in earnings and employment opportunities is based on investigating the changes in the size and significance of ethnicity dummy variables as additional socio-economic variables are added to the regressions.

Sutherland and Alexander (2002) use multinomial logit modelling to examine occupational distributions. From such an approach one can find the probability that a given individual is in a particular occupational class, given that individual's productivity characteristics. The idea is to estimate such probabilities from the sample of the majority group. Then, on the assumption of no discrimination (applying the majority model), one calculates the proportions of the minority group that one would expect to find in each occupational class, given their productivity characteristics. Constrained by relatively small sample sizes, Sutherland and Alexander focus only on Maori-European differences. They find evidence that Maori are consistently segregated into lower occupational classes than their measurable characteristics would predict.

5. The New Zealand data

Until quite recently, researchers were unable to access Statistics New Zealand (SNZ) data at the unit record level. In a recent initiative, SNZ has developed a Data Laboratory as a mechanism for providing access to unit record data. Because of the safeguards and conditions that are in place for the use of the Data Laboratory, use of the facility requires the researchers to access the data in an SNZ office in Auckland, Wellington or Christchurch. No unit-record data can be removed from these secure sites, only the completed statistical analyses. All output is meticulously checked by SNZ staff before release to eliminate the possibility of even inadvertent release of unit record material.

The main sources of microdata possibly relevant for our study are: the Census, Household Economic Survey (HES), Household Labour Force Survey (HLFS) and Income Survey (IS). The latter is a recently introduced annual supplement to the quarterly HLFS.

The problem with Census data has to do with income. Total income from all sources is reported in bands of $5000 to $30 000 except for the open-ended, $100 001 or more. In addition, individuals are asked to report all sources of income, but the total income cannot be broken down by source. Income is pre-tax and includes welfare benefits.

The HES does give much better income data, breaking down the amounts of income received by source. The main difficulty, however, is that the sample size is quite small. The HLFS has a sample size about five times that of the HES, at 15 000 households and approximately 30 000 individuals. Its drawback is that no income questions are asked. However, the New Zealand Income Survey (IS) was run for the first time in the June 1997 HLFS quarter (April to June) as a supplement to the HLFS and is planned to be run in all subsequent HLFS June quarters. According to the June 2000 HLFS, the "survey collects recent gross income data on wages and salaries (up to three jobs), self-employment, government transfers and other transfers which includes private superannuation and annuities."

Statistics New Zealand made available to us, at the Wellington DataLab, data from the 1997, 1998, 1999 and 2000 IS and HLFS. The most important difference in our data set to those used by other researchers is that we asked SNZ to classify separately those respondents who ticked only Maori and those who ticked both Maori and some other ethnic group in answering the ethnicity question. Accordingly, we were able to identify separately those individuals who identify solely with the Maori ethnic group and those (whom we call "mixed") who identify themselves as Maori as well as at least one other classification. This enables us to address the criticism made by Chapple and Rea (1998) and to avoid conclusions that are driven by a changing proportion of the sample identifying as Maori over time. In order for economic discrimination, as defined in Section 3, to operate, there must be observationally distinct groups. We have no information on the degree to which ethnic identification and observational distinctness coincide, but it seems reasonable to assume a lower degree of observational distinctiveness amongst the group describing themselves by multiple rather than single ethnicities.

Table 1 presents descriptive wage data for each year broken down by gender and ethnicity. What the models presented in the next section attempt to do is to devise procedures to examine the issue of whether the differences evident in Table 1 can be explained by the productivity characteristics of the individuals who make up the variously identified groups. It is clear that the raw data indicate that males always earn more per hour in their primary occupation than females, while Pakeha (Europeans) almost always earn more than any other ethnic groups.

6. The models

We estimate the following sample selection model:

$$w_i^* = \mathbf{x}_{1i}'\beta + u_{1i} \quad (3)$$

$$s_i = 1 \text{ if } s_i^* > 0, \; s_i = 0 \text{ otherwise}; \qquad s_i^* = \mathbf{x}_{2i}'\gamma + u_{2i} \quad (4)$$

where $\mathbf{x}_{1i}'$ is the vector of exogenous characteristics described in Tables 2 and 3 and w_i^* is the natural logarithm of person i's wage. The wage is observed only for people who are employed and the binary variable s_i simply indicates whether the individual is employed or not. Thus, the observed wage, w_i is related to w_i^* according to the rule $w_i = w_i^*$ if $s_i^* > 0$.

The vector of independent variables in the selection equation, $\mathbf{x}_{2i}'$, contains every variable in $\mathbf{x}_{1i}'$ apart from the occupational class and part-time dummies defined in Table 3.

The model is estimated by both Heckit and maximum likelihood methods using LIMDEP. The Heckit method is based on the assumption that the error terms (u_{1i},u_{2i}) follow a bivariate normal distribution, and first estimates a probit model for the selection equation (4). The coefficient estimates $\hat{\gamma}$ are used to construct the inverse Mills' ratio $\frac{f(x_{2i}\hat{\gamma})}{F(x_{2i}\hat{\gamma})}$ which is then included in the wage equation to obtain:

$$w_i^* = \mathbf{x}_{1i}'\beta + \rho\sigma_1 \frac{f(x_{2i}\hat{\gamma})}{F(x_{2i}\hat{\gamma})} + \eta_i \quad (5)$$

Equation (5) is then estimated by OLS for the selected sample of employed people. The parameter ρ denotes the correlation between the error terms u_1 and u_2. σ_1 is the standard error of u_1 which is normalized to 1. Because a zero correlation implies no selection bias, it is easy to test the null of no sample selection bias.

The maximum likelihood method estimates equations (3) and (4) simultaneously, making the same assumption about the joint distribution of the error terms. The MLE method produces a direct estimate of the correlation coefficient, ρ, between the two error terms.

Although a probit model is estimated as part of each of the two methods, we do not intend to report the probit results themselves here, as we are primarily interested in the wage equation.

Age and its square are entered in the regressions as proxies for experience. This does fail to account for the details of individuals' differing labour market experiences; for example, females will often take leave from the work force for child rearing purposes. It may be true that Maori and non-Maori males, for instance, have differing labour market experiences. But, it is hard to imagine any supply-side explanation for this (such as the child-bearing argument in the case of the female-male differential) unless such explanation is related to feedback from individuals' difficulties in obtaining employment. In this case the difference

is likely to be associated with some form of discrimination anyway. In any case, we simply do not have access to detailed labour market profiles on the people in our samples. The effect of age on wage is likely to be positive but diminishing, hence the use of the squared term.

Household type dummies, with a couple with no dependent children as the reference class, are included to account for the possibly differing opportunities and incentives facing those with and without children, as well as those living alone. Marital status dummies are included for much the same reason, with a greater expectation of finding a significant effect for those "living as married" than those who are "widowed, separated or divorced", the reference class being "never married".

A set of qualification dummies, ranging from a person's highest qualification being at secondary school level to university level, is used to capture the positive effect of increasing educational qualifications. The reference class is "no qualifications" and one of the qualification groups (containing relatively few observations) is "unspecified" to allow for completeness in treating the sample.

A regional dummy, taking the value 1 for survey participants who reside in one of the three main urban centres, is used to account for relatively lower wages in the provincial areas. A more complete set of regional dummies, based on thirteen regional council areas (using the principal urban area, Auckland, as reference class) was also tried. These results, which we do not present here, indicate that our findings are very robust to this change in specification. Although the regions that show up as negative vary from sample to sample, none of the other estimates differs much.

Ethnicity and gender dummies are included, not for any supposed productivity effect, but to test for discrimination.

The wage regressions do not include all of the variables from the original probits. This is because, if all these variables are included, the inverse Mills' ratio "is essentially a nonlinear function" of them (Hamermesh 1999:19). The variables chosen for exclusion here are the household type variables, which do arguably affect an individual's participation decision, most especially in the case of females, but not the wage offer. There are possibly other candidate variables for exclusion, but all of them have been found, in some previous study or other to affect wages. We believe the approach taken here addresses quite effectively the "exclusion restriction" objection to sample selection models.

The wage regressions also include occupational class and part-time dummies as defined in Table 3. These variables cannot, of course, be defined for individuals who are not observed to be in employment.

Part-time work in the survey is defined as less than thirty hours per week and this dummy is included to allow for the possibility that part-time and full-time work are differently rewarded.

Occupational class dummies allow for the obviously different wage structure of professional against skilled, semi-skilled and unskilled occupations.

The dependent variable in the wage regressions presented here is the natural logarithm of the actual hourly rate (LNACHRLY). Similar results were found using reported "usual" in place of actual hourly rates.

7. Results

We present the results from the wage regressions for both HECKIT and MLE methods in Tables 4 and 5. Table 4 presents the estimates for all coefficients except those concerning gender and ethnicity, which are reserved for table 5.

It is clear from Table 4 that the estimated coefficients are quite robust across the two models and the four years.

The reported coefficients are not immediately economically interpretable but are easily transformed so that the percentage effects of the variables of interest are evident by taking the exponential function of each coefficient. For example, in the case of the qualification variables, this results in average effects over all eight estimates of 1.447, 1.208 and 1.149 for university, post-school and school qualifications, respectively, with very small standard deviations (0.0293, 0.0171 and 0.0218). These numbers are interpretable as indicating 44.7%, 22.9% and 14.9% hourly wage premiums for holders of these qualifications over the unqualified. Given that these represent higher wages for holders of these qualifications *ceteris paribus*, in particular holding constant age, location and occupational grouping, they are all of appropriately plausible magnitudes. The same sort of exercise for the occupational and part-time variables reveals 26.4% and 6.95% positive effects for wage and salary earners in the top and middle occupational classes over those in the lower groupings, with 16.6% lower hourly earnings for part-time workers compared to full-time workers, again *ceteris paribus*.

The age variable enters these regressions in a quadratic from which permits calculation of a turning point, representing the age at which the effect of an extra year becomes negative. The turning point is computed as the negative of the coefficient on AGE divided by twice the coefficient on AGESQ. These estimates range from 45.9 years to 47.8 years across the eight reported estimates, with a mean value of 46.8 and standard deviation of 0.685. Thus, the estimate of the effect of age on earnings is robust and economically plausible.

Before we turn to consideration of the issue of discrimination, the focus of the paper, we note that the robustness and economic plausibility of the effects just considered lends weight to the statistical tests of fit of the models in drawing conclusions. The adjusted R-squared and F-statistic for the model or log likelihood statistics, as appropriate, are reported in Table 4. Also reported are estimates for MILLS (HECKIT models) or RHO (MLE models). These, if significant, indicate the existence of sample selection bias. In the case of the HECKIT models, in only one year, 1999, is there evidence of significant sample selection bias, but for the MLE models there appears to be a sample selection problem in 1997 and 2000. This gives us enough concern to note that the use of OLS is probably not appropriate, although we did estimate a wage regression for each year using OLS and found the results to be very similar to those from both HECKIT and MLE.

Table 5 reports the remaining coefficients from the wage regressions, being those on gender and ethnicity. The economic importance of the estimated effects is calculated in the same way as described above for the qualification and occupational class variables.

In the case of gender the estimated coefficients, which are always statistically significant at a very high level, imply that females, even after controlling for a range of other productivity characteristics, earn between 86.8% and 90.4% of male earnings. The average estimate is 88.6% with a standard deviation of 0.0158. This implies that females' average hourly earnings is 11.4% less than males of similar age and educational background. Some of this difference is often attributed to females' having fewer years of labour market experience as

a result of time devoted to childrearing and to the clustering of females in certain traditional occupations. While no doubt it is possible to explain part of the differential in these ways, the estimate of an 11.4% disadvantage does reflect society's continued under-valuation of child-rearing relative to labour market experience and lower pay in traditionally female-dominated occupations, regardless of the skill demands of that work relative to male-dominated occupations.

The clearest evidence of an ethnic differential in hourly wages is the case of Pacific Peoples relative to Europeans. Corrected for the measured productivity characteristics, Pacific Peoples earn between 86.4% and 89.8% of European earnings, the average estimate being 88.3% (standard deviation of the eight estimates: 0.0121). In each year and for both estimation measures, Pacific Peoples earn statistically significantly less than do measurably similar Europeans. The estimate of the disadvantage is very similar across years and estimation methods and amounts to about 11.7%.

There is similarly strong evidence in the case of "Other" non-European ethnicities (dominated by Asians), with earnings ranging from 88.9% to 94.6% of European, with a mean value of 92.0% and standard deviation of 0.0190, that is a disadvantage of 8.00%.

In the case of Maori, the evidence is not as clear-cut. While the coefficient on MAORI is always negative, it is not significantly different from zero for the MLE method in 1998 and 1999. In the other six estimates, the coefficient on Maori is statistically significant. The average over all eight estimates gives Maori 95.0% of European earnings, although estimates vary as low as 92.4%.

For the remaining ethnic group, "mixed" Maori, the estimated coefficient is negative in five cases and positive in the remaining three, although only in one instance, the HECKIT estimate for 1999, is it significant. In the sole significant case, the estimate implies a 5% wage disadvantage to the group. Calculating across all estimates, we get an implied wage rate of 98.9% of the European wage.

We can discern no obvious pattern of change evident over time with respect to ethnic discrimination. In the case of gender, the estimates of disadvantage for 1999 and 2000 are of the order of 10% and those for 1997 and 1998 about 13 to 14%. The 95% confidence intervals for these estimates do not overlap so there is some evidence for a change.

8. Conclusion

This paper has used only recently made available New Zealand unit record data to estimate wage regressions correcting for sample selection bias by both HECKIT and MLE techniques. We find at least some evidence of a sample selection bias problem and, having appropriately controlled for it, both estimation techniques give very similar results across the four years of data available to us. We find all of the standard wage regression variables to have economically plausible, as well as statistically significant effects. Additionally, we find strong and consistent evidence that females earn less than comparably productive males and that individuals of non-European ethnicities, particularly Pacific Peoples, earn less than comparably productive Europeans. In the case of individuals claiming "mixed" Maori ethnicity there is scarcely any evidence of discrimination. This, and the weaker discriminatory effects against Maori than other non-European ethnic groups, may indicate that the society at large perceives these groups as less observationally distinct from the majority than other non-Europeans. Maori appear to be much more thoroughly integrated

into the Pakeha economy than Pacific Peoples or people of other ethnicities (predominantly Asian).

We find these results to be of sufficient interest to suggest that further study of the issue could be rewarding. The IS data available to us for this study did not cover a range of other variables that could potentially be of interest, including further detail on those who are not currently employed, most especially with respect to their reasons for not seeking work such as child care obligations. Also, a further three years' worth of survey data is now potentially available, which may be enough to start to reveal changes over time. We consider it possibly worthwhile to experiment with non-standard definitions of "part-time" work, to look more closely at the treatment of self-employment in the survey and to see if findings are robust to other changes in the definitions of earnings.

Table 1 Average actual hourly wages (NZ$) in primary job

	1997	1998	1999	2000
Pakeha	14.68	15.22	15.52	18.82
Maori	12.39	13.16	13.14	13.74
Mixed	12.27	12.77	12.78	14.48
Pacific	11.32	12.21	13.59	13.56
Other	14.06	14.85	15.54	15.71
Male	15.54	16.21	16.55	18.29
Female	12.90	13.42	13.76	17.35
Overall	14.24	14.82	15.15	17.82

Table 2 Independent variables in probit analysis

Variable	**Definition**
age variables	
AGE	age in years
AGESQ	square of AGE
ethnicity variables	
MAOR	1 if Maori, 0 otherwise
MIXD	1 if Maori and other ethnic group, 0 otherwise
PACI	1 if Pacific Islander, 0 otherwise
OTHRETH	1 if other ethnic group (except European), 0 otherwise
household type variables	
CWCH	1 if a couple with dependent children, 0 otherwise
SWCH	1 if a single parent with dependent children, 0 otherwise
SOLO	1 if a single parent with no dependent children, 0 otherwise
ONEP	1 if a sole person household, 0 otherwise
OTHRHH	1 if another household type (except couple with no dependent children), 0 otherwise
regional variable	
MCNT	1 if resident in Auckland, Wellington or Canterbury regions, 0 otherwise
marital status variables	
MARR	1 if living as married, 0 otherwise
SEP	1 if separated, divorced or widowed, 0 otherwise
qualification variables	
UNIQ	1 if highest qualification a first degree or higher degree, 0 otherwise
PSCQ	1 if highest qualification post-school but not university, 0 otherwise
SCHQ	1 if highest qualification is school level, 0 otherwise
NSQAL	1 if highest qualification is not specified (but not none), 0 otherwise
gender variable	
GNDR	1 if female, 0 if male

Table 3 Additional variables in wage regression

Variable	**Definition**
occupational variables	1 if in top two occupational groups, 0 otherwise
OCCT	1 if in middle three occupational groups, 0 otherwise
OCCM	
part-time status	
PT	1 if part-time, 0 if full-time
Variable to correct for sample selection bias (Heckit method)	
MILLS	Inverse Mills' ratio

Table 4 Estimated coefficients from wage regressions
Dependent variable: ln(actual hourly rate)

year	**1997**		**1998**		**1999**		**2000**	
variable	**Heckit**	**MLE**	**Heckit**	**MLE**	**Heckit**	**MLE**	**Heckit**	**MLE**
Intercept	1.44 0.0496	1.48 0.340	1.42 0.0484	1.46 0.0416	1.42 0.0484	1.51 0.0407	1.53 0.0512	1.49 0.0364
Age	0.0418 0.00197	0.0411 0.00164	0.0443 0.00188	0.0438 0.00144	0.0394 0.00192	0.0380 0.00142	0.0422 0.00207	0.0429 0.00177
Agesq	-0.000454 0.0000231	-0.000448 0.0000189	-0.000476 0.0000223	-0.000473 0.0000158	-0.000412 0.0000223	-0.000401 0.0000153	-0.000449 0.0000241	-0.000455 0.0000198
Mcnt	0.0745 0.00737	0.0731 0.00746	0.0826 0.00763	0.0806 0.00772	0.109 0.00806	0.106 0.00796	0.0823 0.00777	0.0833 0.00807
Marr	0.0923 0.0126	0.0855 0.0105	0.0964 0.0129	0.0878 0.0118	0.137 0.0132	0.118 0.0121	0.0680 0.0118	0.0778 0.0116
Sep	0.0365 0.0165	0.0408 0.0162	**0.0152** **0.0160**	**0.0166** **0.0160**	0.0358 0.0168	0.0392 0.0154	**-0.0104** **0.0171**	**-0.00987** **0.0171**
Uniq	0.376 0.0160	0.369 0.0144	0.381 0.0183	0.369 0.0174	0.402 0.0190	0.373 0.0168	0.334 0.0176	0.350 0.0150
Pscq	0.201 0.0114	0.195 0.0101	0.187 0.0127	0.178 0.0128	0.211 0.0124	0.194 0.0119	0.168 0.0124	0.177 0.0113
Schq	0.147 0.0126	0.140 0.0116	0.119 0.0132	0.110 0.0132	0.170 0.0128	0.152 0.0138	0.130 0.0136	0.140 0.0124
Nsqal	**-0.105** **0.121**	**-0.1072** **0.103**	0.148 0.0578	0.138 0.0523	0.166 0.0545	0.175 0.0483	0.213 0.0604	0.217 0.0400
Occt	0.218 0.0122	0.219 0.0117	0.225 0.0122	0.226 0.0123	0.243 0.0135	0.244 0.0125	0.250 0.0127	0.249 0.0131
Occm	0.0876 0.00962	0.0874 0.0102	0.0638 0.00957	0.0637 0.0104	0.0607 0.0101	0.0608 0.0107	0.0565 0.0102	0.0562 0.0116
Pt	-0.151 0.00909	-0.150 0.00863	-0.141 0.00902	-0.140 0.00870	-0.200 0.00930	-0.198 0.00893	-0.191 0.00936	-0.193 0.00996
Mills	**-0.0195** **0.0835**		**0.116** **0.0811**		0.260 0.0791		**0.0180** **0.0790**	
Rho		-0.242 0.0488		**0.0679** **0.166**		**0.105** **0.152**		0.274 0.0265
Sample size	14453		14120		13381		13944	
Adjusted R^2	0.304		0.316		0.324		0.297	
F-stat for the model	321		327		324		302	
Log L		-10600		-10400		-10200		-10500

Notes: (1) All estimates are corrected to three significant figures.
(2) Coefficient estimates are followed by their standard errors.
(3) Bold indicates an insignificant estimate.
(4) All other estimates are significant at 5% level or better (one-sided test).

Table 5 Estimated coefficients on gender and ethnicity

year	**1997**		**1998**		**1999**		**2000**	
variable	**Heckit**	**MLE**	**Heckit**	**MLE**	**Heckit**	**MLE**	**Heckit**	**MLE**
Gndr	-0.132 0.00763	-0.134 0.00766	-0.141 0.00769	-0.142 0.00787	-0.106 0.00829	-0.108 0.00839	-0.104 0.00805	-0.101 0.00830
Maori	-0.0552 0.0197	-0.0422 0.0133	-0.0410 0.0208	**-0.0237** **0.0190**	-0.0710 0.0211	**-0.0295** **0.0197**	-0.0688 0.0158	-0.0786 0.0149
Mixd	**-0.0167** **0.0222**	**-0.00775** **0.0233**	**-0.00668** **0.0217**	**0.00211** **0.0238**	-0.0507 0.0231	**-0.0291** **0.0229**	**0.0135** **0.0223**	**0.00427** **0.0231**
Paci	-0.126 0.0209	-0.115 0.0198	-0.124 0.0210	-0.110 0.0217	-0.132 0.0195	-0.107 0.0187	-0.138 0.0191	-0.146 0.0196
Othreth	-0.0896 0.0225	-0.0756 0.0185	-0.118 0.0232	-0.102 0.0219	-0.0919 0.0214	-0.0637 0.0204	-0.0557 0.0216	-0.0724 0.0200

Notes: (1) All estimates are corrected to three significant figures.
(2) Coefficient estimates are followed by their standard errors.
(3) Bold indicates an insignificant estimate.
(4) All other estimates are significant at 5% level or better (one-sided test).

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