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WORKING PAPER 9/2018
June 2018

Working Papers in Public Finance

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June 10, 2018

Abstract

This paper reports estimates for discrete choice labour supply models for New Zealand wage and salary earners for four periods: 1988/89-1992/93, 1993/94-1997/98, 2000/01-2007/08, and 2008/09-2012/13. Utilizing data from the Household Economic Survey (HES) between 1987 and 2013 the appropriate data are pooled and separated into five demographic groups (coupled men, coupled women, single men, single women, and single parents), allowing the estimation of five labour supply models for each year period. By calculating these preferences for varying time periods this provides the opportunity to evaluate how the preference for work, and therefore labour supply responses, had evolved during this time period.

The main purpose of the exercise is to derive the labour supply responses of income units when faced with a change in disposable incomes. A discrete choice labour supply model uses microdata to estimate the preference over income and leisure time for each of these demographic groups, which can then be used to calculate changes in labour supply as disposable income opportunities at varying hours of work change.

Statistics New Zealand disclaimer

Access to the data used in this study was provided by Statistics New Zealand under conditions designed to give effect to the security and confidentiality provisions of the Statistics Act 1975. The results presented in this study are the work of the author, not Statistics NZ.

Acknowledgements

This paper is part of a larger project on 'Improving New Zealand's Tax Policy via International Tax Transfer Model Benchmarking', funded by an Endeavour Research Grant from the Ministry of Business, Innovation and Employment (MBIE) and awarded to the CPF (Professor Norman Gemmell). Access to the data used in this paper was provided by Statistics New Zealand in accordance with security and confidentiality provisions of the Statistics Act 1975. Facilities at the New Zealand Treasury were used when analysing this data. The results presented in this study is the work of the author, not Statistics New Zealand or the New Zealand Treasury. Special thanks goes to Professor John Creedy and Doctor Gulnara Huseynli who provided essential comments for early versions of this paper.

1 Introduction

In this paper, preference functions for individuals' preferences over income and hours of work are estimated. Preference functions are estimated for four subgroups of the New Zealand population: Single females, single males, single parents, and couples. The estimates are at the economic family unit (EFU) level and as a result the labour supply choices of couples are estimated jointly.

Estimates are provided for four separate time periods: 1988-1993, 1994-1998, 2001-2008, and 2009-2013. The data are sourced from the Household Economic Survey (HES) for each of these periods. The data are surveyed on an annual basis, as a result HES years are pooled and deflated to the end of the period for analysis.

By estimating preference parameters for these four separate time periods it is also possible to gain an insight into how these changes in the characteristics of the labour market influenced the labour market choices and outcomes of families in New Zealand.

The periods chosen correspond to four very different labour market situations, the recession of the late-1980s and early 1990s, the sharp recovery from this recession, the long period of growth in the 2000s, and the Global Financial Crisis.

Furthermore the characteristics of the labour market changed considerably during this time. The 1991 Employment Contracts Act (Anderson 1991) and 2000 Employment Relations Act both considerably changed the institutional structure of the New Zealand labour market where labour supply choices were determined - with the net effect a movement away from collective bargaining towards individual employee negotiations. In addition to these policy changes the long-term shift away from manufacturing work towards service jobs and the increasingly technical nature of service work are both shifts that have driven a change in necessary qualifications and the job offers available for individuals.

By estimating preference parameters for differing time periods for the demographic subgroups the relationships are allowed to vary between points in time. As a result, it is possible to gain a richer understanding of how the changes in the labour market structure and economic situation influenced labour market outcomes.

A primary purpose of such an estimation is to simulate the change in

labour supply choices of individuals when the net income available to individuals for different hours of work change. Estimating the preferences individuals have over leisure and consumption in a structural model allows a researcher to ask what hours level would be chosen if the set of available net income were to change, either due to a change in the gross wage rate this individual is paid or an adjustment in the policy parameters (tax and transfers) which transform gross income into net income.

In the New Zealand context, preference parameter estimation for Treasury's microsimulation model has been performed twice, in 2003 Kalb and Scutella (2003) covering the 1991-2001 period and in 2014 Mercante and Mok (2014) covering the 2007 to 2011 period. The parameters estimated in these two different exercises varied in a number of ways, suggesting that the estimated preference parameters do change through time, helping to justify the use of separate time periods in this paper.

The method used is based on the discrete choice framework applied in previous New Zealand estimates. Such a framework deals with the complex budget constraints observed in real world data without applying restrictive assumptions about the properties of the underlying utility function ex-ante. In this framework it is also possible to incorporate the fixed costs of work and observed heterogeneity in the estimated preference parameters.

These preference parameters will be incorporated in Treasury's microsimulation model, TAXWELL-B. The incorporation of these preference parameters in turn allows the analysis of how changes in government tax and transfer policies change the labour supply of individuals and the associated income distribution.

The paper is organised as follows: Section 2 discusses the data used in the paper, selection criteria, and details of the wage imputation process for those out of work. Section 3 describes the method used for estimating preference parameters. Section 4 provides results of the estimation exercise. Section 5 outlines indicative marginal effects from the estimated preference parameters to explain the results. Section 6 concludes.

2 Data sources

The data used for this analysis come from Statistics New Zealand's Household Economic Survey (HES). The HES is a household survey that has

been run annually since the April 1974 year, except for a brief period where it was taken triennially between 1998 and 2006. The HES surveys 5,000 private households[1], with 3,000-4,000 responses of sufficient quality each year. HES years are denoted using the year when the survey ended. For example HES95 refers to the household survey that took place between April 1994 until March 1995.

The survey collects data on income by source, hours of work, and a variety of household, family, and personal characteristics (eg ethnicity). A key advantage of the survey is that it links familial relationships. As a result, this survey allows the construction of economic family units. This allows the estimation of separate wage equations for individuals based on their familial role and to also include variables related to family status (eg partners income, child's age) into the estimation. An economic family unit refers to an adult, the partner, and their dependants.[2]

Using these familial linkages, five key groups are constructed: coupled males, coupled females, single males (without children), single females (without children), and single parents.

Given these demographic groups there are four separate pooled data set for which preference parameters are estimated: HES88-93, HES94-98, HES01-08, and HES09-13. For each pooled data period net incomes were inflated to the final quarter of that period (eg March 1993 for the HES88-93 pooled data). As a result, the average wage rates reported for a given period are not nominal average wage rates of the period but the average real wage rate deflated by CPI for the final quarter of that period.

Survey weights are available for this data, with Treasury estimates of calibrated weights for 1984-2013 available following the method used by Ball and Creedy (2015). However, weights are not used in the estimation of the the preference parameters in this paper given that it is the labour supply response of the simulated sample data that is of interest. This justification is discussed in more detail in Nolan (2018).

[1]Private households exclude institutional households, such as rest homes and prisons.

[2]Partnership is defined as a situation where a defacto or married partner exists. Dependants are children aged below 15, or below 18 and in full-time education.

2.1 Wage imputation and assumptions

The wage data used to construct net incomes for all possible hours levels is the implied wage from wage and salary income in the HES data. This is equal to total current weekly wage and salary earnings from the individual's primary job divided by the number of hours worked per week in their primary job.[3]

As the wage rate is based upon an individual's primary job, the model assumes that the individual only varies labour supply for one job with a fixed gross wage. The labour supply decision that is modelled is the decision of how many hours to work in this job.

On a few occasions inconsistent and unreliable wage data were removed. The key times this occurred were when the calculated wage rate was less than half the minimum wage, when the wage above $150 was reported, and when a very large income was earned on only one hour of work.

However, this wage measure leaves a gap in the data with individuals who are currently not working and therefore not reporting a wage rate. As a result, wage rates have been imputed for those who are not employed. This question of *wage imputation* for those who are out of work is covered in Nolan (2018).

When it comes to implementing this wage imputation for the calculation of net incomes there is a strand of the literature that suggests there are advantages to replacing all wages with their imputed value (eg Loffler et al. (2013) and MacCurdy et al. (1990)).

However, in this paper observed wages are used for those who are employed. The difference between the observed and estimated wage rates is due to unobserved differences between individuals. Using the estimated wage is equivalent to assuming that the unobserved heterogeneity is zero, when in fact we have observed that it is not. This difference is especially important when the a large proportion of the variability in wages is not explained by observed characteristics, as is the case for the estimates used here which come from Nolan (2018).

As a result, there is a significant amount of unobserved heterogeneity in

[3]The earnings from prior jobs, self-employed work, and secondary jobs are ignored when calculating the wage. The primary job is defined as the wage and salary job the individual is currently employed in that offers the largest average weekly income at current hours of work.

the wage data that would be ignored if imputed values were used and so the observed wages rate is the rate applied to calculate the net incomes for those who are currently employed.

A related issue to wage imputation is how the wage available to an individual may vary as they change their hours of work. In the preference parameter estimation performed in this paper, the gross wage is fixed irrespective of the tax-transfer policies used, irrespective of the number of hours worked by the individual, and irrespective of the aggregate number of hours being supplied by all individuals.

However, estimating a labour supply model for such changes, and ignoring the inherent importance of demand (with associated changes in gross wage rates and general equilibrium effects) may lead to a bias in the results. The competing biases, as given by Muller (2014) are:

1. A preference bias: An individual who would be willing to work may not be able to find a job (or sufficient hours). However, the model treats them as if they are voluntarily unemployed. As a result, their preference for leisure is overstated. This downward biases labour supply responses. (eg the labour demand constraint holding in the data is taken as a preference for leisure).

2. A participation bias: An individual facing rationing of hours will be treated as voluntarily unemployed (or underemployed), leading to increases in predicted hours in the model that will not occur. This biases labour supply responses upwards. Here, the labour demand constraint is not allowed to bind in the counterfactual equilibrium.

3. A specification bias: If the labour supply model itself is incorrectly specified, there is an ambiguous bias in the labour supply elasticities that are estimated. For example the model itself being misspecified.

Varying preferences over leisure and consumption in a labour supply model do not solely imply that the relative value individuals place on leisure and consumption changes through time as these differing estimates may in part be due to a changing labour demand conditions, with the availability of jobs at a given wage varying through time. In this paper, each pooled set of years represented different aggregate labour market conditions and as a result the functional job choice set that individuals faced due to labour demand will have also varied. As a result, labour demand considerations appear important for the analysis at hand.

As the bias in the estimated labour supply response is ambiguous, com-

putationally costly, and difficult to apply in practice, it is commonly not accounted for in applied work that aims to solely consider the change in labour market outcomes that occurs. However, if welfare analysis was to be undertaken correcting for this bias would be important - as welfare costs could be considerable from a given policy change even without a large change in hours of work.

There are five ways that the model could be extended, directly or indirectly, to allow some form of labour demand and account for demand associated biases:

1. Iterating the model with labour demand elasticities for tasks/jobs/industries as in Creedy and Duncan (2005) to estimate how the gross wage will adjust given the estimated change in aggregate employment in a labour supply model. Iteration continues until the estimated change in gross wages is sufficiently small.
2. Computable General Equilibrium (CGE) and Behavioural Microsimulation (BMSM) model integration: Full integration between a CGE model and a BMSM offers the most comprehensive structural framework for considering the impact of policy, as not only is the labour market specified, but relative returns to factors are also forced to equalize introducing true GE effects. Examples of this are given in Ahmed and O'Donoghue (2008).
3. Interacting with explicit labour demand models by estimating a labour demand model directly from firm level data as in Bargain et al. (2010).
4. Incorporating a rationing probability (also termed risk of unemployment) directly into the labour supply model as in Bargain et al. (2006) and Muller (2014). In the NZ context this would involve using the HLFS Income supplement data to estimate the rationing probabilities.
5. Job types modelling as in Dagsvik and Strom (2006). Instead of assuming fixed hours or fixed gross wages for the individual, the individual is modelled to choose between a series of combinations of hours and gross wages that exist in the data.

Prior research that has included labour demand extensions have generally shown a reduction in labour supply responses as discussed in Spadaro(2007), Peichl (2008), and Peichl and Siegloch (2012).

However, each of these five methods involves a large extension to the estimation that is applied in this paper and would require additional data and

resources to integrate. Furthermore, relevant quality labour demand data are unavailable for the first two time periods of interest. As a result, in this paper the gross wage has been left fixed. All five of these methods are potential extensions to this analysis which would be especially necessary if welfare analysis were to be undertaken.

2.2 Selection criteria

In addition to the selection criteria used for selecting HES survey respondents, this paper restricts the sample that is used for preference parameter estimation further. For couples, the income unit (both individuals) is excluded from analysis if one of the individuals in the couple meets one of the following conditions. For single individuals the income unit is excluded from analysis if it meets one of these conditions.

- The individual is part of a same-sex couple.
- An individual is self employed.
- The individual is receiving a retirement payment.
- The individual is deemed unable to work (temporarily or permanently) based on their receipt of a sickness or invalid's benefit.
- The individual's wage rate is above \$150 in June 2008 dollars.
- The non-wage income of the entire income unit is above \$260,0000 in June 2008 dollars.

Given those selection criterion, the remaining sample has the following summary statistics.

2.3 Summary of samples

Table 1: Summary Statistics HES88-HES93

	Couple Men	Couple Women	Single Men	Single Women	Single Parents
Average wage rate (if working)	$13.10	$10.47	$11.73	$11.14	$12.16
Employment rate	81.03%	66.58%	79.02%	77.09%	33.80%
Average hours worked	34.10	24.09	34.01	29.82	10.45
Proportion that are female					0.8609
Age/10	3.99	3.84	2.95	3.22	3.459
Number of Children	1.291				1.807
Size of selected sample	9,620		3,230	2,760	1,860
Highest Educational Achievement (proportion)					
No qualification	0.2925	0.3425	0.2950	0.2848	0.5337
School Certificate	0.2591	0.3052	0.3677	0.3912	0.2652
Vocational	0.2919	0.2390	0.2095	0.1857	0.1439
University Graduate	0.1189	0.0815	0.0990	0.1129	0.0356
Other	0.0376	0.0319	0.0288	0.0253	0.0216
Children Variables (proportion of families with dependants)					
Youngest 0	0.141				0.0857
Youngest 1-3	0.1209				0.0884
Youngest 4-5	0.1035				0.1197
Youngest 6-9	0.1630				0.2070
Youngest 10+	0.4719				0.4992

Table 2: Summary Statistics HES94-98

	Couple Men	Couple Women	Single Men	Single Women	Single Parents
Average wage rate (if working)	$17.70	$12.97	$13.50	$12.90	$13.54
Employment rate	82.09%	79.68%	84.37%	84.70%	43.80%
Average hours worked	34.13	32.00	37.26	33.26	13.31
Proportion that are female					0.8779
Age/10	4.05	3.99	3.13	3.47	3.52
Number of Children	1.1914				1.806
Size of selected sample	6680		1,890	1,650	1,050
Highest Educational Achievement (proportion)					
No qualification	0.2416	0.2702	0.2618	0.2273	0.4475
School Certificate	0.2829	0.2923	0.3476	0.3519	0.2910
Vocational	0.2757	0.2721	0.2268	0.2062	0.1708
University Graduate	0.1642	0.1366	0.1404	0.1753	0.0725
Other	0.0355	0.0287	0.0233	0.0393	0.0181
Children Variables (proportion of families with dependants)					
Youngest 0	0.1303				0.0802
Youngest 1-3	0.1148				0.0954
Youngest 4-5	0.1146				0.1269
Youngest 6-9	0.1841				0.1889
Youngest 10+	0.4562				0.5086

Table 3: Summary Statistics HES01-08

	Couple Men	Couple Women	Single Men	Single Women	Single Parents
Average wage rate (if working)	$20.88	$18.60	$18.18	$17.89	$17.73
Employment rate	89.67%	76.99%	83.96%	84.22%	57.25%
Average hours worked	38.23	28.75	34.98	32.05	18.46
Proportion that are female					0.8659
Age/10	4.31	4.23	3.35	3.78	3.70
Number of Children	1.0273				1.7210
Size of selected sample	5,540		1,650	1,450	840
Highest Educational Achievement (proportion)					
No qualification	0.1462	0.1637	0.1731	0.1462	0.2611
School Certificate	0.3629	0.3770	0.4320	0.3988	0.4192
Vocational	0.1893	0.1987	0.1671	0.1632	0.1449
University Graduate	0.2456	0.2048	0.1908	0.2370	0.1198
Other	0.0559	0.0558	0.0371	0.0548	0.0551
Children Variables (proportion of families with dependants)					
Youngest 0	0.1315				0.0635
Youngest 1-3	0.0971				0.0683
Youngest 4-5	0.1171				0.1222
Youngest 6-9	0.1973				0.2036
Youngest 10+	0.4570				0.5425

Table 4: Summary Statistics HES09-13

	Couple Men	Couple Women	Single Men	Single Women	Single Parents
Average wage rate (if working)	$29.81	$22.07	$21.53	$21.57	$22.55
Employment rate	94.14%	68.52%	78.08%	78.12%	55.86%
Average hours worked	41.10	23.34	31.18	28.18	18.26
Proportion that are female					0.8686
Age/10	4.27	4.16	3.35	3.70	3.79
Number of Children	1.0058				1.7025
Size of selected sample	4,510		2,130	2,130	1,130
Highest Educational Achievement (proportion)					
No qualification	0.1161	0.1303	0.1310	0.1072	0.2131
School Certificate	0.4164	0.4477	0.5399	0.4534	0.4929
Vocational	0.1421	0.1323	0.0948	0.1171	0.1057
University Graduate	0.2717	0.2335	0.1986	0.2723	0.1394
Other	0.0537	0.0562	0.0357	0.0499	0.0488
Children Variables (proportion of families with dependants)					
Youngest 0	0.1410				0.0675
Youngest 1-3	0.2791				0.2149
Youngest 4-5	0.1050				0.1083
Youngest 6-9	0.1669				0.2123
Youngest 10+	0.3079				0.3970

The summary data shows that there were clear differences between the sample periods.

One of the largest differences between the HES09-13 period and other pe-

riods is the higher employment rate of couple males in this selected sample. While the Global Financial Crisis saw employment rates for all other groups decline, couple male sample employment rates rose significantly. Although a higher employment rate is consistent with other data such as the Household Labour Force Survey, the magnitude of the difference is not and is a primary driver of the difference in the couples model for HES09-13 below.

Other key differences were a decline in the number of children, age of children, an increase in in highest educational achievement, and a higher average age.

The number of children declined for both couples and single parents across the surveys. In both proportional and absolute terms the decline was largest for couples, with the average number of children among couples falling from 1.291 in HES88-93 to 1.006 in HES03-13. The average number of children in single parent households declined from 1.807 to 1.703 over the same period.

The HES09-13 sample was also an outlier in terms of the age grouping of children. The HES09-13 period had a disproportionately large number of children aged 1-3 for couples and single parents, and a correspondingly disproportionately small number of children aged 10+.

Educational attainment also increased over the time period, with the proportion of the sample who were university graduates rising by 15-16 percentage points for coupled males, coupled females, and single females and by 10 percentage points for single males and single parents.

The average age of the sample rose over time for all demographic groups, increasing by between 3 years for coupled females and 5 years for single females.

There were also certain between demographic-subgroup differences that were maintained over time.

Single females and coupled males remained more qualified than other demographic subgroups, with higher proportions of university graduates and lower proportions of those without high school certificate.

Single males always tended to be younger than other demographic subgroups in the sample, with the average age reaching only 33 by HES09-13. The average age of both partners in a couple tends to be older than other demographic subgroups, with single females and single parents in-between couples and single males.

Employment rates tended to be lower for coupled females and sole parents then they were for other groups over the entire time horizon. This is consistent with the fact that having a child increases the reservation wage for individuals. As, in the majority of cases, it is the female partner who takes a break from work to look after a child, this shows up more strongly in coupled female participation than coupled male participation.

Further differences in the distribution of participation and hours are discussed in Section 2.3.

2.4 Distribution of hours

The purpose of this paper is to model the observed distribution of wage and salary (W&S) hours worked as a function of individuals preference over leisure and consumption. As a result, it is valuable to describe the distribution of observed hours for each demographic subgroup and how these distributions changed over time.

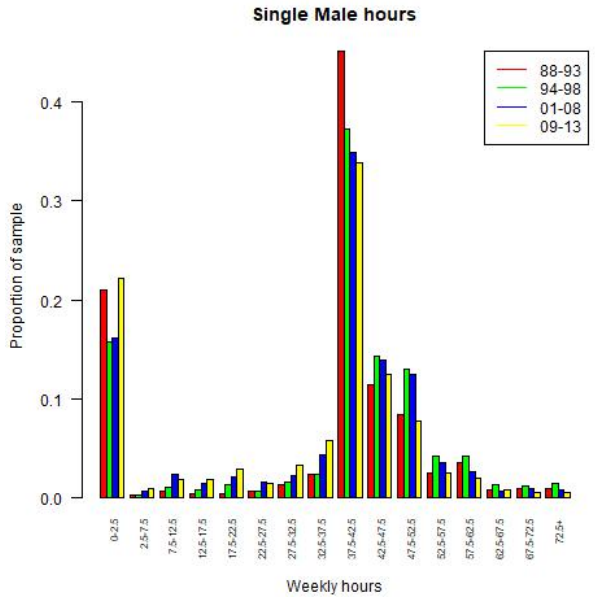

Figure 1: Single Male W&S hours distribution

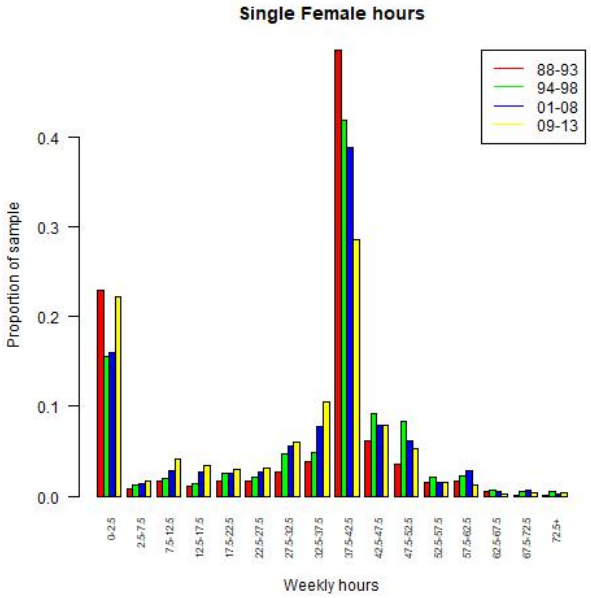

Figure 2: Single Female W&S hours distribution

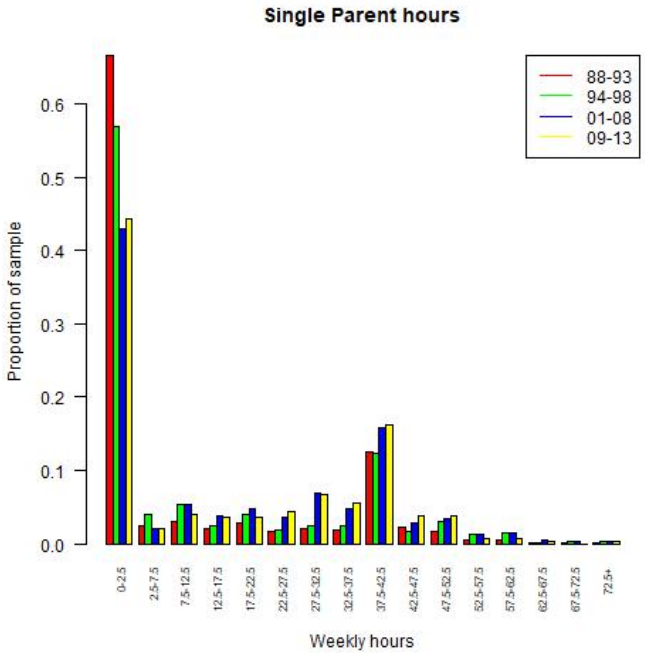

Figure 3: Single Parent W&S hours distribution

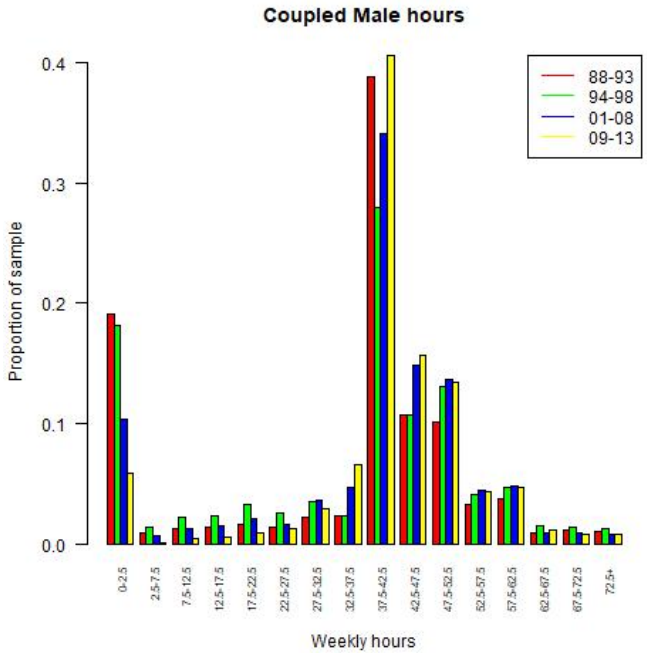

Figure 4: Coupled Male W&S hours distribution

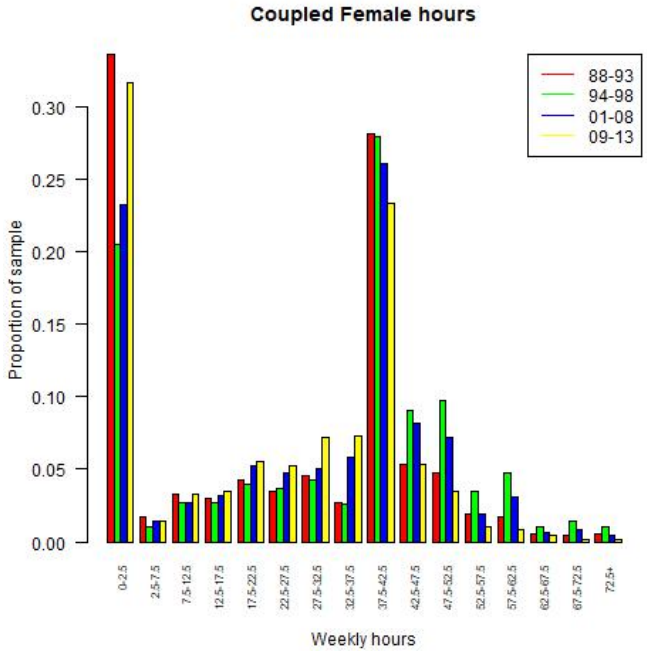

Figure 5: Coupled Female W&S hours distribution

The above graphs show that, apart from single parents and coupled males in HES09-HES13, there has been a movement away from approximately 40 hours of work per week in the HES sample.

As part of this movement all groups, except for coupled males, have experienced an increase in the share of the demographic group working less than 40 hours per week. The proportion of single males working between 2.5 and 37.5 hours per week rose from 5.7% to 17.8% between HES88-93 and HES909-13, for single females the increase was from 13.6% to 32%, for single parents it was 15.8% to 30%, and for coupled females from 22.8% to 33.4%. Unlike other groups, the increase in hours worked below 40 for single parents was also associated with an increase in the proportion of individuals working 40+ hours, as for single parents there has been a general move away from non-participation to participation.

Coupled males have behaved differently to other groups in this regard. By HES09-13, 12.6% of coupled males worked less than 40 hours per week up slightly from 11.2% in HES88-93. However, the rate of non-participation had declined during this period. As a result, the proportion of coupled males working more than 42.5 hours per week rose from 30.8% to 40.8%.

The differences in non-participation between the late 1980s/early 1990s recession and the recession following the 2008 Global Financial Crisis (GFC) can also be seen in the data. Both samples had lower aggregate employment rates than the intervening years , but the distribution of these lower employment rates varied based on the individuals demographic subgroup.

Single males, single females, and coupled females all experienced a sharp increase in non-participation between HES01-08 and HES09-13 towards the levels reported in the HES88-93 survey. Although single parents experienced saw non-participation rise slightly between HES01-08 and HES09-13, non-participation for this group was well below its level in earlier years. Finally for couple men non-participation in the sample continued to decline sharply in the GFC period - a shift that was at odds with all other groups.

All across the hours ranges in Figures 1-5 there is no instance when there was no-one in the sample at a given hours level. As a result, there is a broad range of hours that are relevant to consider when thinking about the labour supply choices of individuals: it is not the case that individual's only have the opportunity to work either zero or 40 hours, with a variety of hours points being observed in reality.

2.5 Variables used

The model of preferences for income and work is specified in terms of weekly income and weekly hours of work. However, these preferences are not homogeneous among individuals of the same group, and as a result other characteristics are included in the estimation to account for some of this observed heterogeneity.

Due to the smaller sample size used in each model than in Kalb and Scutella (2003), this paper focuses on a reduced number of characteristics. When estimating heterogeneity in the linear parameters for the preference to work and preference for income, data on age, highest educational achievement, spouses highest educational achievement, number of children, and age of youngest child is used.

The key variable missing from prior estimates is a variable denoting region of residence. However, unemployment and year trends were also removed and interaction terms were not included. Interaction terms added very little to prior estimates and increased standard errors when they were introduced in many of the estimates below, as a result they were excluded from all equations.

3 Parametric model, specification, and estimation

When considering the labour supply response of individuals to changes in their net incomes it is necessary to define and estimate the parameters of a decision rule that these agents follow. The preference parameters that are estimated in this paper represent the preferences of agents who follow a defined rule when choosing their hours of work.

The decision rule assumes that agents maximise their family level utility with their choice of hours of work. A family is defined as an Economic Family Unit which is compromised of an adult, their partner (if applicable), and any dependent children.

This utility function is a positive function of consumption, c, and leisure, l. Families are endowed with characteristics z, a quantity of hours TE, and some non-labour income y_0. The families decision rule then allocates these hours between leisure and hours of work, where working generates income that can be spent on consumption. Here the choice variable in the decision rule is the hours of work for adults in the family, h.

The labour supply choice can then be modelled as a choice between hours of work and hours of leisure. An early version of this model which focuses on the choice of the hours of work in continuous time is Hausman (1980). For this model the notation of Spadaro (2007) is used. The vector of gross wages, including imputed wages, are termed w and net taxes are denoted NT. The agent's maximisation problem then takes the form:

$$Max\ u(c, l; z; \beta, \epsilon)\ st\ c \leq y_0 + wh - NT(wh, h, y_0; z; \gamma) \tag{1}$$

Where γ represents parameters of the tax-benefit system, and β and ϵ are coefficients that parameterise preferences. The goal of this paper is to estimate these preference parameters.

The maximisation yields a continuous labour supply function that can be estimated from household microdata as:

$$h = F(w, y_0; z; \beta, \epsilon; \gamma) \tag{2}$$

Where β and ϵ need to be estimated, as everything else is observed. For each agent, i, β is defined as a shared preference term, and ϵ_i is an idiosyncratic individual preference (treated as a random error term). Given this, for each agent hours are estimated as:

$$h_i = F(z_i, w_i, y_{0i}; \beta, \epsilon_i; \gamma) \tag{3}$$

However, MacCurdy et al. (1990) raised significant concerns about this type of model. Given non-linear taxes and transfers the data give a non-linear budget constraint, and it is possible for parts of the budget constraint to be non-convex. Furthermore, there is an endogeniety problem with the tax rate and hours of work jointly determined.

As a result, in order to get *model coherency* it is essential to make a prori assumptions about the functional form of preferences in order to ensure that necessary conditions for the parameters of the model are met and/or to oversimplify the budget constraint relative to reality. This limits the flexibility of the model, makes maximum likelihood estimation of the parameters more difficult, and also may place inappropriate restrictions on model outcomes.

In order to deal with these criticisms, a discrete hours approach to estimating the labour supply can be utilised.

3.1 Discrete hours: van Soest's method

A common way to reduce the computational burden of estimation and limit assumptions about the functional form of preferences, is to have agents choose from a discrete set of potential working hours as shown in van Soest (1995). In this case the agent i picks from a discrete choice set of j income and leisure alternatives, $\{(y_j, l_j)\}$. In the same way as in the continuous hours approach, β and ϵ_i are estimated given the assumption that the agent is picking the level of hours h that is optimal.

Creedy and Kalb (2005) discusses the process of estimation in more detail. The agent is assumed to maximise utility with error. This implies that they choose h that maximises expected utility where: [4]

$$u_j^* = u_j(h_j|z_i) + v_j \tag{4}$$

This model is known as a *Random Utility Model*. When interpreting v_j this error term could be due to mismeasurement of characteristics, unobserved characteristics, or optimization errors by agents. Given this characterisation of the agents choice, it is possible to generate a probability distribution for labour supply which can be used to calibrate labour supply choices in a microsimulation model.

Equation 4 describes a distribution of utility for each discrete hours level, depending on the distribution of v_j. Utility maximisation implies that for K discrete hours levels, where $j, g \in K$, u_j^* is chosen when $u_j^* \geq u_g^* \; \forall g$. Replacing these terms with the deterministic utility component and the stochastic error, we can say that for v_j the probability of j being chosen is the joint probability of $v_g \leq v_j + u_j - u_g$ over all g.

Take $P(v_g \leq v_j + u_j - u_g)$ as the probability that $u_j^* > u_i^*$ and so j is chosen above i. Assuming the various distributions are independent gives the conditional probability for a given value of v_j:

$$\Pi_{g \neq j} P(v_g \leq v_j + u_j - u_g) \tag{5}$$

As this provides the conditional probability for a single draw of v_j, the full probability of the jth hours level being chosen can be found by summing this probability over all possible values of v_j.

[4] A significantly more detailed discussion with reference to the Melbourne model MITTS can be found in the book Creedy et al. (2002).

If v_j takes only a discrete values, a_k for $k = 1, \ldots, K$ then p_j (the probability h_j is chosen) can be represented as:

$$p_j = \sum_{k=1}^{K} \left[\Pi_{g \neq j} F(a_k + u_j - u_g)\right] f(a_k) \tag{6}$$

Where $f(a_k)$ is the proportion of values in the error distribution that equals a_k, and $F(a_k)$ is the proportion of values that are less than or equal to a_k. A numerical example of this is given in Creedy and Kalb (2005).

When v is a continuous random variable (although the hours choice continues to be discrete) this sum becomes:

$$p_i = \int_{-\infty}^{+\infty} \left[\Pi_{g \neq j} F(v_j + u_j - u_g)\right] f(v_j) dv_j \tag{7}$$

Where $f(v)$ is the density function of v and $F(v)$ is the distribution function of v.

The functional form of v is often assumed to be of the extreme value distribution.[5]. This involves taking the density function:

$$f(v) = e^{-v} e^{-e^{-v}} = exp(-v - e^{-v}) \tag{8}$$

Which gives the distribution function:

$$F(v) = e^{-e^{-v}} \tag{9}$$

Then p_j can be derived as:

$$p_j = \frac{e^{u_j}}{\sum_{g=1}^{n} e^{u_g}} \tag{10}$$

Given p_{ij} as the probability that hours level j is selected by individual i, given N individuals, and given a variable d_{ij} that equals 1 when j hours

[5] A detailed description of why this functional form is used can be found in Maddala (1983) This function holds the favourable property of *independence from irrelevant alternatives* McFadden (1974). Another way of viewing this assumption is discussed in Dagsvik and Jia (2008), with the condition termed the assumption of probabilistic rationality.

levels are selected and 0 otherwise, we can define the log likelihood function as:

$$lnL = \sum_{i}^{N} \sum_{j}^{J} d_{ij} \ln p_{ij} \tag{11}$$

McFadden (1974) states that the maximum likelihood estimator is then the appropriate estimator for the parameters in this model.

Given this structure, microdata are then used to estimate the unobserved parameters of the model, the preference parameters that make up unobserved utility.

In the discrete hours approach, the relevant parameters can be defined over any legitimate utility function. Once a form for the utility function has been decided upon, the maximum likelihood estimator over the previously defined probability function can be used to estimate the parameters of interest. These parameters give a probability distribution of hours for each individual.

A quadratic utility function is used in the same vein as Blundell et al. (2002), Kalb and Scutella (2003), and Mercante and Mok (2014). This utility function is used due to its ease of implementation, and the fact that the type of utility function used appears to have little impact on the calculated labour supply elasticities, according to Loffler et al. (2013).

For a family unit, a quadratic utility function takes the form:

$$\begin{aligned} u_i =& \beta_1 Y_i + \beta_2 Y_i^2 + \beta_3 Lm_i + \beta_4 Lf_i + \beta_5 Lm_i^2 + \beta_6 Lf_i^2 \\ &+ \beta_7 Y_i Lm_i + \beta_8 Y_i Lf_i + \beta_9 Lm_i Lf_i \end{aligned}$$

Where Y_i is the family unit's income, Lm_i is male leisure and Lf_i is female leisure. Leisure is defined as the time endowment remaining after hours of work are subtracted. Conceptually, this framework can be further extended to consider changes in time use by splitting the leisure component into pure leisure and housework as it is in Kabátek et al. (2014). However, the purpose of such a decomposition is to add to the welfare analysis of hours worked rather than to improve estimates of the labour supply choice. As the choice of hours of work is the focus of this paper this additional decomposition is not undertaken in this paper.

Following Kalb and Scutella (2003) and Mercante and Mok (2014) the utility function has been defined in terms of hours worked rather than leisure time. Defining male hours of work as hm and female hours of work as hf the estimated utility function takes the form:

$$\begin{aligned} u_i =& \beta_1 Y_i + \beta_2 Y_i^2 + \beta_3 hm_i + \beta_4 hf_i + \beta_5 hm_i^2 + \beta_6 hf_i^2 \\ &+ \beta_7 Y_i hm_i + \beta_8 Y_i hf_i + \beta_9 hm_i hf_i \end{aligned} \tag{12}$$

The utility function used incorporates a fixed cost of work. As an extension of labour supply models this stems from Cogan (1980). This was first implemented in this specific discrete hours framework in Euwals and van Soest (1999). The purpose of the fixed cost of work extension is two-fold. First there are fixed costs associated with taking up a job for an individual, and secondly as van Soest (1995) notes the incorporation of fixed costs helps to improve the fit of the model given that discrete labour hours models tend to overestimate the number of individuals taking on part time work.

As a result, the researcher can either adjust the utility function as in van Soest (1995) or remove an estimate of the fixed cost of employment from the net income for potential set of hours of work as in Mercante and Mok (2014). The second option is used in this paper to keep consistency with prior estimates of preference parameters for New Zealand. However, estimates for both forms were produced and the results reported were not very sensitive to the form of fixed costs used.

Fixed cost estimates in these models may be higher than an analyst intuitively expects when considering the material costs of taking up a job. In this model, the estimate of a fixed cost of working should not be seen as an estimate of the material costs of moving into work, but an estimate that includes the non-pecuniary costs of working as argued by Aaberge et al. (1995).

The role of the fixed costs parameter is to make part time work relatively unattractive, as a result estimates tend to be higher for groups that have a smaller observed group of individuals working part time. Given this, the fixed cost estimate can be seen as picking up unobserved characteristics that may be driving the choice about whether to participate in the labour market or not, or the choice about whether to work full time or part time. Furthermore, if the availability of hours is constrained on the demand side,

which is likely, the fixed cost of work parameter will also represent this demand side constraint.

The final extension to the model involves making the preference parameters vary based on the observed characteristics of the individuals surveyed. The linear preference parameters over both income and hours of work can be made dependent on a variety of socio-demographic characteristics. This allows for heterogeneity in the preference parameters to be estimated as a function of the observed characteristics of the individuals.

3.2 Estimation

The preference parameters are estimated using maximum likelihood where the log-likelihood function is defined using equation (11).

Numerical methods, specifically the BFGS quasi-Newtown method, is applied for optimisation in this paper. The general-purpose optimization package in R, *opm*, is used to perform this as outlined in Nash (2016). In each case this involved minimising a negative log-likelihood and as a result the positive semi-definiteness of the Hessian was checked to ensure a local minimum was achieved.

A wide range of initial conditions were used with this method without the estimated parameters varying considerably. Given that the likelihood surface can become relatively flat, convergence was checked with initial conditions starting both above and below the estimated values. Furthermore, initial conditions from estimated model without demographic characteristics were used to check for convergence.

Other methods were experimented with, especially for the single person estimates. Initial estimates using the non-gradient Nelder-Mead method appeared reasonable relative to prior New Zealand estimates and on average required a lower fixed cost to fit the data. However, both the magnitude and sign of these estimates were very sensitive to initial conditions, especially the estimates of fixed costs.

For comparison purposes all the available models in the optimization package *opm* were estimated for singles, including a box-constraint model using economically intuitive constraints. The BFGS method gave the most consistent results, that satisfied quasi-concavity and local minimisation, among these methods.

It is possible to introduce unobserved heterogeniety into the preference parameters of the model using simulated maximum likelihood as discussed in Kalb and Scutella (2003). This can be applied using the *mlogit* package in R as described by Croissant (2018).

However, the unobserved heterogeneity terms tend to add little to the results as shown in Kalb and Scutella (2003) and Mercante and Mok (2014) and TAXWELL-B is already designed to make use of results without these terms. Preliminary estimates for single people in HES01-08 using unobserved heterogeniety also indicated that these terms do not effect the parameter estimates. As a result, estimates excluding these terms, which are the same coefficients that can be applied to TAXWELL-B, are reported in this paper.

4 Results of estimation

The estimated quadratic utility function includes observed heterogeneity in the preference for work and income, typically dummy variables representing given characteristics of individuals. As a result, the estimated parameters for the individual characteristics are relative to a reference individual. In the case of all individuals, the reference individual is someone without Year 11 qualifications. Furthermore where the demographic grouping includes dependants, the youngest child is assumed to be over 9 years of age.

It is common for the preference for work to rise with age, peak, and then decline for all demographic groups. The approximate peak age and its change through time is described below.

Table 5: Single Male Estimates

	1988-93		1994-98		2001-08		2009-13	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Hours worked								
Constant	2.1134	0.0000	1.6122	0.0000	-0.6536	0.0041	-0.7137	0.0001
Age$\div 10$	1.0703	0.0000	-0.0277	0.7810	0.9868	0.0000	0.8153	0.0000
Age$^2 \div 100$	-0.1360	0.0000	-0.0067	0.6211	-0.1223	0.0000	-0.0907	0.0000
High school diploma	0.0944	0.1378	0.1334	0.0046	-0.0330	0.5939	-0.0592	0.2555
Vocational training	0.2893	0.0000	0.2493	0.0000	0.1286	0.0779	-0.1166	0.0860
Other education	-0.0330	0.8186	0.0263	0.8403	-0.1065	0.3390	-0.0538	0.5688
University graduate	0.1296	0.1409	0.0432	0.5595	0.0457	0.5316	0.0020	0.9734
Weekly Income (hundreds)								
Constant	0.5582	0.0000	3.2719	0.0000	-0.0196	0.8262	0.1466	0.0658
Age	0.3587	0.000	0.1427	0.5075	0.2303	0.0008	0.1618	0.0009
Age$\div 10^2$	-0.0441	0.0000	0.0118	0.6795	-0.0241	0.0034	-0.0160	0.0085
High school diploma	-0.0260	0.2775	-0.4714	0.0000	-0.0295	0.3020	-0.0153	0.5772
Vocational training	0.0357	0.2227	-0.5099	0.0000	0.0028	0.9389	-0.0276	0.4439
Other education	-0.0411	0.4656	-0.6512	0.0061	-0.0779	0.1436	-0.0152	0.7627
University graduate	-0.0304	0.3984	-0.1142	0.3753	-0.0079	0.8267	0.0061	0.8506
Fixed Costs (hundreds)	13.3261	0.0000	2.0388	0.0000	12.2844	0.0000	11.5981	0.0000
Quadratic Terms								
Hours	-0.7111	0.0000	-0.1971	0.0000	-0.1322	0.0000	-0.1237	0.0000
Income	0.0003	0.947	-0.0374	0.0000	0.0006	0.7377	0.0011	0.4349
Interaction Terms								
Hours Income	-0.2135	0.0000	-0.3549	0.0000	-0.0510	0.0009	-0.0844	0.0000
Model Fit								
Percent correctly predicted	24.2%		34.4%		25.5%		24.6%	

Estimates for single males are reported in Table 5.

As expected, for single males the marginal utility of work declines as the hours of work increase for all time periods. However, the estimated rate of decline was very different between the HES88-93 period and other periods - with a much sharper decline in the preference for work in HES88-93.[6]

The age relationship for the utility of work is relatively consistent for all periods except HES94-98. Each other period shows the utility of work peaking in a single males 40s - at 40 for HES88-93, 41 in HES01-08, and 45 in HES09-13. In HES94-98, the estimated marginal utility of falls monotonically by age with both the age and squared age terms not statistically different from zero.

Vocational training appeared to increase the utility of work in the HES88-93 and HES94-98 estimates, but outside of this single males preference for work was invariant to highest qualification achieved.

For single males, the utility of income varies across periods. The largest discrepancy is between HES94-98 and the other time periods. For other

[6]These are shown by the quadratic hours term in Table 5

time periods the coefficient on squared income, which represents the way the marginal utility of income changes with the level of income, is small and positive, but not significantly different from zero. In the HES94-HES98 estimate this term is negative and significant.

The effect of age on the utility of income is relatively constant across periods except HES94-98. The estimated age where the preference for income peaks was 41 in HES88-93, 48 in HES01-08, and 51 in HES09-13. For the HES94-98 estimate the preference for income rises continuously with age.

Other than the HES94-98 estimates, highest education level was largely unrelated to single males utility of income. However, for HES94-98 the achievement of school certificate, vocational training, and other education were all strongly negatively related to the utility of income.

Estimated fixed costs for single males are high for all periods except HES94-98. These high fixed costs were above the Kalb and Scutella (2003) estimates but significantly below the large Mercante and Mok (2014) estimates. Higher fixed costs for the single male group makes is consistent with the fact that this group has a low proportion of individuals in part-time employment.

However, the fixed cost estimates for the HES94-98 year were substantially lower than the Kalb and Scutella (2003) estimates and this papers estimates for other years, even though the proportion of individuals in part time work was not out of line with other years. This in combination with the varying estimates for other variables in this model indicates that the underlying data-generating process for this sample differed strongly from the other periods.

Table 6: Single Female Estimates

	1988-93		1994-98		2001-08		2009-13	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Hours worked								
Constant	0.9121	0.0000	0.4808	0.0287	-0.4749	0.0130	0.5817	0.0000
Age$\div 10$	0.6148	0.0000	0.4678	0.0000	0.7061	0.0000		
Age$\div 10^2$	-0.0915	0.0000	-0.0689	0.0000	-0.0892	0.000		
High school diploma	0.2304	0.0000	0.3535	0.0000	0.1372	0.0073	-0.1071	0.3939
Vocational training	0.2603	0.0000	0.3850	0.0000	0.2288	0.0002	0.1478	0.0266
Other education	0.1393	0.0852	0.2847	0.0021	0.1204	0.1569	0.1331	0.0155
University graduate	0.1682	0.0013	0.5601	0.0000	0.1880	0.0042	0.3101	0.0000
Weekly Income (hundreds)								
Constant	1.6754	0.0000	0.7986	0.0005	0.5248	0.0086	0.2969	0.0006
Age	0.4154	0.0044	0.1175	0.3433	0.2706	0.0111		
Age$\div 10^2$	-0.0522	0.0073	-0.0122	0.4361	-0.0309	0.0195		
High school diploma	0.1075	0.1124	0.0912	0.1506	-0.1124	0.0819	-0.0432	0.3746
Vocational training	0.0850	0.2728	0.0877	0.2145	0.0193	0.8048	-0.0161	0.6859
Other education	0.1072	0.5038	0.1774	0.1532	-0.0347	0.7422	0.1237	0.6042
University graduate	0.3737	0.5999	0.4641	0.000	0.0547	0.4772	0.0301	0.1072
Fixed Costs (hundreds)	3.0819	0.0000	4.358	0.0000	4.1312	0.0000	13.5790	0.0002
Quadratic Terms								
Hours	-0.2756	0.0000	-0.2170	0.0000	-0.1272	0.0000	-0.1222	0.0000
Income	0.0129	0.0439	-0.0198	0.0120	0.0018	0.6276	0.0014	0.2576
Interaction Terms								
Hours Income	-0.4406	0.0000	-0.1443	0.0000	-0.1444	0.0000	-0.0502	0.0000
Model Fit								
Percent correctly predicted	39.7%		23.5%		23.4%		24.0%	

Estimates for single females are reported in Table 6.

In a similar fashion to single males, single females marginal utility of work declines as the number of hours worked rises - but the size of this reduction fell over time. Outside of HES88-93, this falling marginal utility of work closely matched that of single males.

The general shape of the age relationship for the utility of work is consistent with prior estimates, with the marginal utility of work rising with age but at a declining rate. The marginal utility of work by age peaks at 34 in the HES88-93 and HES94-98 estimates, and at 40 in the HES01-08 estimates.

For HES09-13, the age relationship was removed. When age variables are included the model still converges, and the likelihood function is maximised. However, the constant and age terms for both the utility of income and hours are large (with opposite signs) and the estimated marginal utility of income at observed hours is negative for nearly a third of the sample data. As a result, this suggests that there is insufficient variation with age and that the model is poorly specified with age included.

Although educational attainment is positively associated with the utility

of work for single females, it is only university level qualifications that offer a statistically significant increase over all time periods.

For single females, the estimate for the change in the marginal utility of income as income rises varied across the time periods from slightly positive in HES88-HES93 to slightly negative in HES94-98.

The utility of income is estimated to rise with age until the age of 40 in HES88-93, 49 in HES94-98, and 44 in HES01-08.

Through HES88-93 until HES01-08 the fixed-cost estimates are low relative to other groups but marginally higher than previous estimates for New Zealand. However, fixed cost estimates increase considerably in the HES09-13 estimate, rising above the estimate for single males.

Given that part time employment was at a higher level than at any prior period in HES09-13 the sudden increase in estimated fixed costs appears surprising. However, with the age relationship removed from this model the underlying estimate is fundamentally different from other years.

Table 7: Single Parent Estimates

	1988-93		1994-98		2001-08		2009-13	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Hours worked								
Constant	-1.0906	0.0533	-0.7633	0.0719	0.0921	0.8444	-1.7977	0.0155
Age$\div 10$	0.700	0.0134	0.2482	0.2333	0.2130	0.3369	1.1785	0.0001
Age$\div 10^2$	-0.0847	0.0168	-0.0326	0.1631	-0.0320	0.2564	-0.1297	0.0011
High school diploma	0.1352	0.0323	0.2168	0.0001	0.1954	0.0020		
Vocational training	0.2168	0.0011	0.3030	0.0000	0.3046	0.0002		
Other education	0.3172	0.0244	0.3773	0.0130	0.1103	0.3232		
University graduate	0.3794	0.0001	0.4020	0.0000	0.1466	0.1045		
Youngest Child 0	-0.1096	0.5321	-0.5218	0.0022	-0.7731	0.0000	-0.0568	0.7734
Youngest Child 1-3	-0.4107	0.0000	-0.4509	0.0000	-0.4576	0.0000	-0.0564	0.5891
Youngest Child 4-5	-0.1997	0.0342	-0.4106	0.0000	-0.3903	0.0000	-0.2454	0.0229
Youngest Child 6-9	-0.3396	0.0000	-0.2468	0.0000	-0.2477	0.0000	-0.1179	0.1096
Number of Children	0.0333	0.2893	-0.0668	0.0284	0.0063	0.8302	-0.0669	0.0523
Weekly Income (hundreds)								
Constant	0.7484	0.0212	0.7853	0.1707	1.9090	0.0048	-0.0810	0.5786
Age	-0.1353	0.3570	0.1110	0.7005	-0.3560	0.2724	0.0910	0.4474
Age$\div 10^2$	0.0172	0.3569	-0.0079	0.8248	0.0402	0.3256	-0.0105	0.4723
High school diploma	-0.0573	0.1147	-0.1516	0.0931	0.0548	0.5385		
Vocational training	-0.0767	0.0769	-0.1600	0.1163	-0.1271	0.2382		
Other education	-0.0301	0.7416	-0.3285	0.1325	0.07573	0.6189		
University graduate	-0.0575	0.4139	0.1604	0.2523	0.06908	0.5371		
Youngest Child 0	0.2677	0.0119	0.7272	0.0071	0.2549	0.1857	0.0616	0.2399
Youngest Child 1-3	0.0326	0.5442	0.3087	0.0188	0.1522	0.1765	0.0284	0.3243
Youngest Child 4-5	0.0624	0.2668	0.0396	0.7526	-0.0492	0.6599	-0.0093	0.6119
Youngest Child 6-9	-0.0329	0.4164	-0.0316	0.7477	-0.0696	0.4095	-0.0055	0.7150
Number of Children	0.0370	0.0567	0.0641	0.1467	-0.0172	0.6168	0.0032	0.6026
Fixed Costs (hundreds)	6.7716	0.0000	2.6157	0.0000	3.271	0.0000	23.41	0.1084
Quadratic Terms								
Hours	-0.0768	0.0020	0.0702	0.0074	-0.1058	0.0004	-0.1400	0.0000
Income	-0.0170	0.0179	-0.0663	0.0000	-0.0253	0.0003	-0.0026	0.2965
Interaction Terms								
Hours Income	-0.0359	0.0429	-0.0646	0.0022	-0.0565	0.0009	-0.01297	0.3660
Model Fit								
Percent correctly predicted	66.3%		57.9%		43.5%		43.4%	

Estimates for single parents are reported in Table 7.

In terms of the marginal utility of work for single parents, every period except HES94-HES98 had marginal utility falling as the hours of work rose. This decline increased through time in the data.

The HES94-HES98 estimate suggested that the marginal utility of work increased with hours worked. This time period had the highest proportion of single parents working part time, while EMTR's were high and so the additional income associated with increasing hours for part time work was limited. As a result, increasing marginal utility of work was the only way to fit the single parent data for this period.

The age relationship for single parents takes a similar shape over the time periods under investigation. The utility of work peaks at the age of 42 in

HES88-93, 39 in HES94-98, 34 in HES01-08, and 46 in HES09-13. However, the implied disutility of work increases more rapidly with age in HES09-13 than other years implying that the relative preference for young sole parents to work is much higher during this time.

In the first three time periods the age of the child has a strong negative relationship on a sole parents utility from work at all ages. However, the HES09-13 sample shows a much weaker relationship.

Through HES88-93 until HES01-08, educational completion had a positive impact on the utility of work for sole parents. In the HES09-13 sample the effect was unstable and the variables were removed from the analysis.

In terms of the marginal utility of income, diminishing marginal utility of income holds for all the estimated time periods.

The age relationship is inconsistent across years. However, the estimated relationship is not statistically significant in any of the time periods. The same holds for educational attainment and the child variables.

The fixed-cost term required to fit the distribution behaved in a similar manner to single females between HES88-93 and HES01-08. The estimated fixed costs were well below the estimates in Kalb and Scutella (2003), and declined as employment including part time employment increased for single parents.

However, the fixed cost term increased significantly in the HES09-13 estimate, well above the low estimates in Mercante and Mok (2014). The employment rate declined in this period (although it is still higher than it was in HES88-93) and furthermore the proportion of employed individuals in part time employment had more than doubled between HES88-93 and HES09-13. At face value these facts makes the increase in the fixed cost surprising.

As mentioned above the effect of age on the utility from work is substantially different in magnitude in HES09-13 suggesting that the behaviour of sole parents in different age groups varied more significantly in this period then it did in other periods. Given this heterogeneity by age, a higher fixed cost term will have been necessary to ensure that sufficient numbers of sole parents stayed out of employment.

Table 8: Couple Estimates

	1988-93		1994-98		2001-08		2009-13	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Male partner Hours worked								
Constant	2.700	0.0000	0.6132	0.0002	2.0286	0.0000	3.7669	0.0000
Age$\div 10$	0.4659	0.0000	0.4461	0.0000	0.3612	0.0000	0.8555	0.0000
Age$\div 10^2$	-0.0667	0.0000	-0.0632	0.0000	-0.0503	0.0000	-0.1035	0.2132
High school diploma	0.0533	0.0072	0.0808	0.0028	0.0552	0.1626	-0.0028	0.9573
Vocational training	0.1461	0.0107	0.2295	0.0005	0.1005	0.1305	-0.1036	0.1261
Other education	0.1009	0.0043	0.1567	0.0000	0.0137	0.7501	-0.5861	0.2350
University graduate	0.3186	0.0000	0.2635	0.0000	0.1129	0.0007	-0.1506	0.0001
Youngest Child 0	-0.3473	0.0000	-0.3924	0.0000	-0.2525	0.0000		
Youngest Child 1-3	-0.2968	0.0000	-0.3219	0.0000	-0.2331	0.0000		
Youngest Child 4-5	-0.2742	0.0000	-0.2619	0.0000	-0.1811	0.0000		
Youngest Child 6-9	-0.1487	0.0000	-0.1502	0.0000	-0.0394	0.3730		
Number of Children	-0.0425	0.0845	-0.0351	0.2640	-0.0312	0.3801		
Partner High school diploma	0.0941	0.0000	0.0822	0.0017	0.1332	0.0003	0.0473	0.3768
Partner Vocational training	-0.0310	0.5932	-0.0411	0.5909	-0.0245	0.7176	0.1469	0.0261
Partner Other education	0.0918	0.0087	0.0778	0.0423	0.1959	0.0000	0.0976	0.0422
Partner University graduate	-0.1118	0.0583	-0.0442	0.5297	0.0647	0.3585	0.0956	0.7764
Female Hours worked								
Constant	0.5392	0.0000	0.0530	0.7327	0.8839	0.0000	-0.0748	0.6001
Age$\div 10$	0.5327	0.0000	0.4495	0.0000	0.2550	0.0000	0.2138	0.0000
Age$\div 10^2$	-0.0785	0.0000	-0.0640	0.0000	-0.0420	0.0000	-0.0231	0.7333
High school diploma	0.0755	0.1480	0.0736	0.3562	-0.0098	0.8470	0.0535	0.2233
Vocational training	0.2199	0.0000	0.1983	0.0000	0.1085	0.0038	0.0248	0.4598
Other education	0.1712	0.8332	0.3457	0.2832	-0.1056	0.9130	-0.0434	0.9887
University graduate	0.3389	0.4849	0.2721	0.3851	0.0416	0.953	-0.0230	0.9743
Youngest Child 0	-0.6013	0.0000	-0.3586	0.0000	-0.5273	0.0000		
Youngest Child 1-3	-0.4640	0.0000	-0.2793	0.0000	-0.3505	0.0000		
Youngest Child 4-5	-0.3557	0.0000	-0.2336	0.0000	-0.2326	0.0000		
Youngest Child 6-9	-0.2123	0.0000c	-0.1143	0.0000	-0.1531	0.0000		
Number of Children	-0.0402	0.0000	-0.03996	0.0000	-0.04833	0.0000		
Partner High school diploma	0.0968	0.0653	0.1008	0.1233	-0.0232	0.6774	0.0376	0.4095
Partner Vocational training	-0.0519	0.0087	-0.0382	0.2626	-0.0278	0.4440	0.0749	0.0245
Partner Other education	-0.0340	0.0063	-0.0387	0.1092	-0.0873	0.0025	0.0976	0.0004
Partner University graduate	-0.1297	0.0000	-0.1555	0.0000	-0.0578	0.0863	0.0956	0.0060
Weekly Income (hundreds)								
Constant	0.5846	0.0000	0.8050	0.0000	0.5193	0.0000	0.3049	0.0000
Number of Children	-0.0132	0.1877	-0.0228	0.0497	-0.0196	0.1327	0.0061	0.9017
Male Fixed Costs (hundreds)	14.791	0.0000	5.5014	0.0000	13.5514	0.0000	39.82	0.0000
Female Fixed Costs (hundreds)	8.9528	0.0000	5.6627	0.0000	9.9019	0.0000	13.98	0.0000
Quadratic Terms								
Male Hours	-0.4590	0.0000	-0.1388	0.0000	-0.3455	0.0000	-0.7795	0.0000
Female Hours	-0.1332	0.0000	-0.0342	0.0032	-0.1117	0.0000	-0.1229	0.0000
Income	-0.0033	0.0000	-0.0092	0.0000	-0.0009	0.0542	-0.0006	0.0115
Interaction Terms								
Male Hours Income	-0.0592	0.0000	-0.0578	0.0000	-0.0394	0.0000	-0.0295	0.0000
Female Hours Income	-0.0371	0.0000	-0.0472	0.0000	-0.0234	0.0000	-0.0151	0.0000
Male Hours Female Hours	-0.2362	0.0000	-0.1121	0.0000	-0.1198	0.0000	-0.0794	0.0000
Model Fit								
Percent both correctly predicted (deterministically)	11.6%		11.8%		10.7%		17.2%	

Estimates for couples are reported in Table 8.

For both coupled males and females, the marginal utility of work declines with hours worked for all estimated periods.

For coupled males, the effect of age on the utility of work was relatively consistent between HES88-93 and HES01-08. However, by HES09-13 the estimated peak utility of work by age rose significantly along with the associated constant, a result that is consistent with the very high employment rate for couple males in the HES09-13 sample. The peak utility of work occurred at 35 in HES88-93, 36 in HES94-98 and HES01-08, and 42 in HES09-13.

The effect of age on coupled females utility of work was relatively consistent between HES88-93 and HES94-98. However, in HES01-08 and HES09-13 the estimated peak utility of work had fallen. In HES09-13 the constant also declined, helping to fit the drop in the employment rate during this period.

The peak utility of work for coupled females occurred at 34 in HES88-93, 36 in HES94-98, 27 in HES01-08, and 47 in HES09-13. However, the difference in peak ages is partially a result of the varying specification of the HES09-HES13 model relative to other time periods. Specifically, information about the number and age of children in not used for the hours preference estimation in this time period.

Educational attainment increased the utility of work, especially for coupled males, in the HES88-93 and HES94-98 periods. However, this effect became insignificant over the 2000s and for coupled males it broadly turned negative by HES09-13.

Relative to other time periods, the HES09-13 estimates do not include children variables in the estimation of male or female preferences for hours of work. The introduction of these terms lead to the Hessian no longer being positive semi-definite. The only terms that were estimated to be significant were the age of the child for females, and the inclusion of these variables also increase the linear coefficient for hours of work. As a result, the exclusion of the child variables seems appropriate for this period.

For earlier time periods the estimated coefficient for coupled females took the expected sign given that, on average, the male-breadwinner view of family organisation remained dominant during this period. The younger the child, the lower a coupled female's preference for work, and the greater the number of children, the lower the estimated utility of work. These es-

timates were relatively in line with prior literature.

However, the a lower marginal utility of work given a younger child and more children was also estimated for coupled males. Although the coefficients were smaller than for coupled females they were still large and significant. A result that differs from prior New Zealand estimates. These results were robust to multiple specifications and initial values. Intuitively, having a child increases the opportunity cost of an hour of work for both males and females so these estimates appear consistent.

The marginal utility of income declines with income for all periods, indicating that diminishing marginal utility holds for these estimates.

The number of child term was relatively insignificant across time periods, except for HES94-HES98 when the number of children had a statistically significant negative effect on the utility of income. This is surprising given that a greater number of children would be expected to increase the value of income to the family unit. However, this result is consistent with prior New Zealand estimates.

Males fixed cost estimates were higher than female estimates for all periods, excepting HES94-98 where the two terms were close. Coupled male fixed costs were lower than prior estimates for New Zealand between HES88-93 and HES01-08. However, fixed cost estimates were much higher in the HES09-13 estimates, above the already high HES07-11 estimates in Mercante and Mok (2014). The same relative trend, although at a lower level, holds for female fixed costs.

In the HES09-13 period the coupled male data behaved very differently from other demographic subgroups, with part-time employment and non-participation both falling sharply. The sharp increase in the density of the hours distribution towards high hours of work irrespective of the individual's characteristics forces a large fixed cost term to ensure that some individuals do not participate.

4.1 Estimated hours distribution

Given the estimated parameter values the probability of an individual working at a discrete hours point is given by equation (10). The average value of these probabilities for a discrete hours point over the entire sample gives the *probabilistically predicted* employment at each of these points.

These values can then be compared to the observed values in order to evaluate the it of the models.

The reported part time employment percentage is the proportion of people who are employed and working one of the employment categories that are 25 hours or below. For coupled males the discrete hour categories are larger, and part time employment is for those in the 20 hour or below group.

Table 9: Single Female Hours Frequency Distributions

	1988-93	1994-98	2001-08	2009-13
	Observed			
Employment rate	77.09%	84.70%	84.22%	78.13%
Employed Part Time %	9.1%	11.0%	14.5%	19.8%
Employed 0 hours	22.98%	15.60%	15.98%	22.25%
Employed 5 hours	0.83%	1.27%	1.35%	1.65%
Employed 10 hours	1.74%	1.93%	2.84%	4.19%
Employed 15 hours	1.09%	1.39%	2.71%	3.48%
Employed 20 hours	1.63%	2.54%	2.57%	2.96%
Employed 25 hours	1.70%	2.18%	2.71%	3.15%
Employed 30 hours	2.71%	4.78%	5.62%	6.07%
Employed 35 hours	3.87%	4.90%	7.72%	10.49%
Employed 40 hours	49.76%	41.34%	38.86%	28.65%
Employed 45 hours	6.23%	9.19%	7.85%	7.95%
Employed 50 hours	7.46%	14.39%	11.78%	9.17%
Total	2760	1650	1480	2130
	Probabilistically Predicted			
Employment rate	77.01%	84.42%	83.95%	77.67%
Employed Part Time %	10.0%	13.0%	16.9%	23.4%
Employed 0 hours	22.99%	15.58%	16.05%	22.33%
Employed 5 hours	0.09%	0.38%	0.77%	1.23%
Employed 10 hours	0.32%	0.88%	1.38%	2.04%
Employed 15 hours	0.85%	1.65%	2.22%	3.23%
Employed 20 hours	2.00%	2.94%	3.69%	4.94%
Employed 25 hours	4.46%	5.13%	6.15%	7.11%
Employed 30 hours	8.96%	8.56%	9.67%	9.47%
Employed 35 hours	14.56%	12.83%	13.40%	11.54%
Employed 40 hours	17.89%	16.60%	15.98%	12.84%
Employed 45 hours	16.43%	18.30%	16.34%	13.08%
Employed 50 hours	11.44%	17.14%	14.38%	12.20%
Total	2760	1650	1480	2130

Table 10: Single Male Hours Frequency Distributions

	1988-93	1994-98	2001-08	2009-13
	Observed			
Employment rate	79.02%	84.36%	83.96%	78.08%
Employed Part Time %	2.6%	4.5%	9.3%	11.3%
Employed 0 hours	20.98%	15.69%	16.10%	22.21%
Employed 5 hours	0.25%	0.16%	0.61%	0.89%
Employed 10 hours	0.56%	0.95%	2.31%	1.83%
Employed 15 hours	0.31%	0.74%	1.34%	1.83%
Employed 20 hours	0.37%	1.32%	2.00%	2.82%
Employed 25 hours	0.56%	0.58%	1.58%	1.46%
Employed 30 hours	1.30%	1.48%	2.25%	3.24%
Employed 35 hours	2.35%	2.28%	4.25%	5.77%
Employed 40 hours	45.25%	37.36%	34.93%	33.90%
Employed 45 hours	11.36%	14.26%	13.91%	12.44%
Employed 50 hours	16.71%	25.17%	25.17%	13.62%
Total	3230	2010	1650	2130
	Probabilistically Predicted			
Employment rate	79.00%	84.36%	83.87%	77.79%
Employed Part Time %	1.9%	4.7%	10.3%	13.0%
Employed 0 hours	21.00%	15.64%	16.13%	22.21%
Employed 5 hours	0.00%	0.06%	0.37%	0.40%
Employed 10 hours	0.00%	0.23%	0.71%	0.78%
Employed 15 hours	0.03%	0.54%	1.29%	1.46%
Employed 20 hours	0.23%	1.06%	2.30%	2.70%
Employed 25 hours	1.23%	2.04%	4.00%	4.77%
Employed 30 hours	4.73%	4.43%	6.64%	7.71%
Employed 35 hours	12.24%	9.56%	10.30%	11.17%
Employed 40 hours	20.78%	17.15%	14.79%	14.48%
Employed 45 hours	23.03%	23.84%	19.59%	16.81%
Employed 50 hours	16.72%	25.44%	23.89%	17.52%
Total	3230	2010	1650	2130

Table 11: Single Parents Hours Frequency Distributions

	1988-93	1994-98	2001-08	2009-13
	Observed			
Employment rate	33.80%	43.80%	57.25%	55.86%
Employed Part Time	35.6%	40.9%	34.2%	32.0%
Employed 0 hours	66.68%	56.87%	42.99%	44.23%
Employed 5 hours	2.43%	3.91%	2.04%	2.04%
Employed 10 hours	3.02%	5.44%	5.27%	4.09%
Employed 15 hours	2.05%	2.39%	3.83%	3.64%
Employed 20 hours	2.75%	4.01%	4.79%	3.64%
Employed 25 hours	1.62%	1.91%	3.59%	4.44%
Employed 30 hours	2.10%	2.48%	6.95	6.66%
Employed 35 hours	1.89%	2.39%	4.79%	5.51%
Employed 40 hours	12.45%	12.31%	15.81%	16.25%
Employed 45 hours	2.16%	1.72%	2.87%	3.82%
Employed 50 hours	2.86%	6.58%	7.07%	5.68%
Total	1860	1050	840	1130
	Probabilistically Predicted			
Employment rate	33.27%	43.41%	57.26%	56.00%
Employed Part Time	38.82	43.2%	37.8%	35.2%
Employed 0 hours	66.73%	56.59%	42.74%	44.00%
Employed 5 hours	1.93%	4.38%	2.54%	2.10%
Employed 10 hours	2.32%	4.08%	3.73%	2.94%
Employed 15 hours	2.60%	3.63%	4.57%	3.81%
Employed 20 hours	2.88%	3.34%	5.14%	4.88%
Employed 25 hours	3.18%	3.32%	5.63%	5.96%
Employed 30 hours	3.50%	3.54%	6.31%	6.93%
Employed 35 hours	3.84%	3.99%	7.07%	7.60%
Employed 40 hours	4.16%	4.68%	7.65%	7.79%
Employed 45 hours	4.39%	5.60%	7.64%	7.43%
Employed 50 hours	4.47%	6.84%	6.96%	6.56%
Total	1860	1050	840	1130

Table 12: Coupled Female Hours Frequency Distributions

	1988-93	1994-98	2001-08	2009-13
	Observed			
Employment rate	66.58%	79.68	76.99%	68.52%
Employed Part Time	15.6%	14.1%	17.3%	19.0%
Employed 0 hours	33.65%	20.53%	23.26%	31.65%
Employed 5 hours	1.68%	1.02%	1.39%	1.44%
Employed 10 hours	3.24%	2.69%	2.72%	3.24%
Employed 15 hours	2.99%	2.67%	3.16%	3.53%
Employed 20 hours	4.22%	3.98%	5.24%	5.53%
Employed 25 hours	3.47%	3.72%	4.78%	5.22%
Employed 30 hours	4.57%	4.24%	5.04%	7.21%
Employed 35 hours	2.69%	2.61%	5.86%	7.26%
Employed 40 hours	28.09%	27.97%	26.12%	23.37%
Employed 45 hours	5.31%	9.08%	8.23%	5.35%
Employed 50 hours	10.09%	21.49%	14.19%	6.19%
Total	7060	4600	3890	4500
	Probabilistically Predicted			
Employment rate	66.34%	79.38%	76.60%	69.84%
Employed Part Time	16.6%	13.6%	17.0%	22.8%
Employed 0 hours	33.66%	20.62%	23.40%	30.16%
Employed 5 hours	1.36%	1.22%	1.25%	1.93%
Employed 10 hours	2.12%	1.74%	2.01%	3.00%
Employed 15 hours	3.10%	2.45%	3.07%	4.37%
Employed 20 hours	4.32%	3.43%	4.46%	5.95%
Employed 25 hours	5.72%	4.77%	6.19%	7.55%
Employed 30 hours	7.24%	6.59%	8.20%	8.94%
Employed 35 hours	8.77%	9.02%	10.29%	9.85%
Employed 40 hours	10.19%	12.22%	12.27%	10.09%
Employed 45 hours	11.36%	16.34%	13.90%	9.62%
Employed 50 hours	12.16%	21.58%	14.96%	8.55%
Total	7060	4600	3890	4500

Table 13: Coupled Male Hours Frequency Distributions

	1988-93	1994-98	2001-08	2009-13
	Observed			
Employment rate	81.03%	82.09%	89.67%	94.14%
Employed Part Time	5.7%	10.6%	6.3%	2.8%
Employed 0 hours	19.69%	18.90%	10.75%	5.93%
Employed 10 hours	2.35%	4.19%	2.52%	0.78%
Employed 20 hours	3.38%	6.37%	3.80%	2.06%
Employed 30 hours	4.32%	5.19%	5.55%	4.88%
Employed 40 hours	48.97%	38.35%	50.26%	59.62%
Employed 50 hours	21.29%	26.99%	27.12%	26.73%
Total	7060	4600	3890	4500
	Probabilistically Predicted			
Employment rate	80.37%	81.06%	89.31%	93.97%
Employed Part Time	3.9%	9.0%	4.6%	0.9%
Employed 0 hours	19.63%	18.94%	10.69%	6.03%
Employed 10 hours	0.33%	2.36%	0.51%	0.01%
Employed 20 hours	3.57%	6.68%	4.13%	0.87%
Employed 30 hours	16.44%	14.86%	17.13%	14.53%
Employed 40 hours	32.52%	25.21%	34.41%	47.70%
Employed 50 hours	27.57%	31.94%	33.13%	30.86%
Total	7060	4600	3890	4500

The above tables show that the model tends to fit the employment rate fairly well, with the estimated number out of work very close to the observed number.

However there are two clear differences between the prediction and the observed data: part time employment of 15+ hours tends to be slightly overestimated, while the clear peak in hours worked at 40 hours per week is spread across the 35-50 hours levels by the model. These issues are common for this form of estimation, as mentioned by Kalb and Scutella (2003).

4.2 Quasi-concavity

One of the advantages of a discrete hours framework for preference parameter estimation is that restrictions to parameter values do not need to be imposed ex-ante, and can instead be checked following the estimation. This involves checking the quasi-concavity of the observed data points after estimation as in Kalb and Scutella (2003) and Mercante and Mok (2014).

No more than 0.5% of the observed data failed a test of quasi-concavity for any of the observed models, implying that the utility function is quasi-concave in the relevant regions of the model for the majority of households.

5 Marginal Effects

The marginal effects are shown below. These effects take the sample as given for each time period, and then change a single characteristic to a counterfactual value for all individuals in the sample. The average expected hours of work per week, and estimated participation rates, given this change in characteristics are then calculated.

Table 14: Single Parents Marginal Effects

	1988-93	1994-98	2001-08	2009-13
Expected hours per week				
From base	10.36	12.94	17.97	17.92
Disposable income increase of 10%	10.70	12.97	18.48	18.40
Youngest Child aged 0	12.16	7.13	7.49	16.51
Everyone Graduate	5.96	17.71	17.65	17.92
Age increase 10%	10.36	12.51	17.53	18.84
Participation				
From base	33.80%	43.80%	57.26%	56.00%
Disposable income increase of 10%	34.55%	44.76%	59.30%	57.57%
Youngest Child aged 0	38.89%	32.98%	31.19%	51.05%
Everyone Graduate	15.06%	46.56%	53.82%	56.00%
Age increase 10%	33.42%	42.18%	56.57%	58.32%

For Single Parents a 10% boost to disposable income at each hours point increases participation rates and average hours in all periods.

Setting all single parents youngest child to an age of zero leads to lower participation rates in HES94-98, HES01-08, and HES09-13. Given that it is common for a parent to stay home to look after their child in the months after their birth this makes sense. HES88-93 shows the opposite relationship, with a higher participation rate for those with a youngest child at the age of 0. Even though the coefficient on the preference to work is negative for this equation, the term is much more negative for children aged 1-9 while the preference for income is higher. Furthermore, even after increasing overall participation rates are low relative to other groups.

The effect of education is variable for single parents. In HES94-98 there was a small increase in participation when considering university graduates, HES01-08 a small decline, and HES09-13 education was excluded. In HES88-93 graduate education led to a significant drop in participation. However, this was based on a very small sample (66 individuals or 3.5% of the time period single parent sample).

A higher age for single parents led to a slight decline in participation in HES88-93, HES94-98, and HES01-08. For HES09-13 participation rates

increased following an exogenous 10% increase in the age of the sample.

Table 15: Single Male Marginal Effects

	1988-93	1994-98	2001-08	2009-13
Expected hours per week				
From base	33.10	35.81	34.01	30.39
Disposable income increase of 10%	34.90	35.48	34.87	30.93
Age increase 10%	33.04	35.53	33.34	30.79
Graduate	35.55	35.25	34.70	31.22
Participation				
From base	78.90%	84.36%	83.87%	77.79%
Disposable income increase of 10%	83.72%	82.65%	85.11%	78.36%
Age increase 10%	78.52%	83.31%	81.58%	78.06%
Graduate	84.83%	81.99%	84.73%	78.70%

An exogenous 10% increase in disposable income is predicted to increase single male participation and hours worked for most of the time period, except for 1994-98. Similarly, educational attainment increases participation in all time periods except 1994-98. These two results illustrate the difference between the HES94-98 estimates and other years for single males.

The effect of a 10% increase in the average age in the sample was to reduce participation in HES88-93, HES94-98, and HES01-08. However, an increase in the sample's age increased participation and hours in the HES09-13 estimates. Single men are the, on average, youngest demographic subgroup. With the age that represents the peak preference for work for single males also shift out to their 50s in this period, the increase in participation in the final time period is logically consistent

Table 16: Single Female Marginal Effects

	1988-93	1994-98	2001-08	2009-13
Expected hours per week				
From base	29.73	32.73	31.31	27.52
Disposable income increase of 10%	27.53	37.04	32.92	33.28
Age increase 10%	28.90	31.67	30.21	27.52
Graduate	28.50	37.40	32.80	33.37
Participation				
From base	77.00%	84.42%	83.95%	77.67%
Disposable income increase of 10%	69.89%	85.35%	85.31%	85.88%
Age increase 10%	74.77%	81.86%	81.60%	77.67%
Graduate	71.68%	87.51%	84.91%	85.92%

Higher disposable income led to an increase in average hours of work for single females in the HES94-98 and HES09-13 estimates. Although the HES09-13 figure was also associated with a large increase in participation, the HES94-98 estimate only saw a small increase in participation, indicating that single females were working longer hours. HES01-08 saw a small increase in participation and hours due to higher disposable income, while HES88-93 saw participation fall sharply.

An increase in age was associated with lower labour force participation across all time periods for single females, except for HES09-13 where age was excluded from estimation.

Table 17: Coupled Female Marginal Effects

	1988-93	1994-98	2001-08	2009-13
Expected hours per week				
From base	23.55	30.65	27.87	22.90
Disposable income increase of 10%	23.73	30.71	28.23	23.28
Youngest Child 0	17.81	27.50	22.72	22.90
Graduate	31.19	35.20	28.53	21.39
Partner Graduate	18.91	25.85	27.05	23.81
Age increase 10%	22.03	29.30	26.17	22.86
Partner age increase 10%	23.80	30.82	27.93	22.64
Participation				
From base	66.34%	79.38%	76.60%	69.84%
Disposable income increase of 10%	66.93%	79.90%	77.45%	70.88%
Youngest Child 0	52.52%	72.63%	65.06%	69.84%
Graduate	80.85%	87.29%	77.94%	66.40%
Partner Graduate	57.50%	70.89%	75.24%	71.32%
Age increase 10%	63.10%	76.81%	73.19%	69.78%
Partner age increase 10%	66.58%	79.45%	76.47%	68.98%

For coupled females, a 10% increase in disposable income leads to a rise in both participation and expected hours of work in all time periods.

An increase in a coupled females age reduced average expected hours of work and participation in all time periods. Increasing the age of the individual's partner had a more mixed effect, increasing participation in HES88-93 and HES94-98 while decreasing participation in HES01-08 and HES09-13. However, the magnitude of the change in expected hours and participation from an increase in the age of a coupled females partner was very small.

From HES88-93 to HES01-08, graduate education increased participation for coupled females and having a partner with a graduate qualification reduced participation. This effect reversed in HES09-13, with graduate

education reducing participation while having a partner with graduate education increased participation.

Although this effect wasn't mirrored for coupled males, the reversal from higher participation when the individual's are graduates to higher participation when partners are graduates in the HES09-13 estimates did occur. As a result, the intuitive relationship that the most qualified partner will be the partner that works - which held in the HES88-93 to HES01-08 estimates - appears to have been contradicted in the HES09-13 estimates.

Setting the age of the youngest child to 0 for all couples with children lead to a large decline in participation and average expected hours in HES88-93 and HES01-08. Participation and hours also declined in HES94-98, but by a smaller magnitude than in the neighbouring years. The decline in the HES94-98 estimates is similar to the reduction in participation by coupled males, while the decline in HES88-93 and HES01-08 was much larger for females than males. No effect is observed in HES09-13 as child variables were excluded from estimation.

Table 18: Coupled Male Marginal Effects

	1988-93	1994-98	2001-08	2009-13
Expected hours per week				
From base	32.44	32.09	36.34	39.04
Disposable income increase of 10%	32.35	31.97	36.36	39.15
Youngest Child 0	29.99	28.94	34.88	39.04
Graduate	38.53	36.17	37.35	37.73
Partner Graduate	27.48	30.21	36.36	38.10
Age increase 10%	31.15	30.77	35.21	37.95
Partner age increase 10%	32.71	32.25	36.42	39.04
Participation				
From base	80.37%	81.06%	89.31%	93.97%
Disposable income increase of 10%	80.43%	81.26%	89.55%	94.36%
Youngest Child 0	74.35%	74.45%	85.97%	93.97%
Graduate	91.30%	87.83%	90.95%	91.84%
Partner Graduate	71.18%	78.24%	89.52%	92.23%
Age increase 10%	77.70%	78.59%	87.21%	91.86%
Partner age increase 10%	80.65%	81.14%	89.19%	93.96%

Increasing family disposable income for coupled males slightly increased participation for all time periods. However, average hours of work were close to unchanged.

For coupled males an increase in age lead to a relatively consistent decline in participation across time periods, falling by between 2 to 3 percentage points. A rise in the age of the coupled males partner increased participation in the HES88-93 and HES94-98 estimates and reduced participation in the HES01-08 and HES09-13 estimates, but these changes were much smaller in scale than those associated with own-age changes.

The education relationship varied across the time periods analysed. In HES88-93 graduate qualification led to a sizeable increase in participation, while partner graduate qualifications led to a reduction. These ef-

fect narrowed in HES94-98 and HES01-08, but participation when coupled males were graduate qualified remained higher than participation when males partners were graduate qualified. In HES09-13, both own and partner graduate qualification led to a decline in participation, with own-qualification leading to a lower participation rate.

Having a new born child reduces the labour supply of both couple males and females, the effect appears to be strong for coupled females in most time periods. This reduction shrunk in HES01-08 relative to the estimated reduction in the 1990s.

6 Conclusion

In this paper preference parameters were estimated for four demographic groups, single males, single females, single parents, and couples. These estimates were performed for four separate time periods: HES88-93, HES94-98, HES01-08, and HES09-13.

During the 1988-2013 period the aggregate and subgroup outcomes in the labour market changed considerably, and in ways that varied across the subgroups. While part time work became more popular among single people without children and coupled females, sole parents and coupled men moved more heavily into full time work. Although the evolution of labour market outcomes may partially be the result of changes in the characteristics of individuals, the institutional structure of the labour market, economic conditions in the period of analysis, and the preferences of individuals towards work and work income also changed over this time. This can be seen in the way preference parameter estimates varied across time horizons.

For all demographic groups the age where the utility of work peaks shifted, becoming older. Estimates of the fixed costs of work tended to fall in the HES94-98 estimates and rose sharply in the HES09-13 estimates across demographic groups. Across most demographic groups the disutility associated with work rose at a slower rate in later time periods than it did in HES88-93, with the coupled male HES09-13 the only outlier although this is likely due to the change in the model specification which sharply increased the fixed cost of work for this subgroup.

However, there is enough in common between the estimates, and associated economic logic, to make them credible. The utility associated with

work peaks between an individuals mid-30s and mid-40s, having a child lowers the utility from supplying labour to females, and in most instances higher educational attainment leads to a greater labour force participation.

Similar relationships held in the previous New Zealand research in Kalb and Scutella (2003) and Mercante and Mok (2014). However, there were some clear differences. Coupled males labour supply falls when their are dependants in the household in this paper, while no significant effect is found in the prior research. Furthermore, the HES09-13 education results differ both other years and the prior New Zealand research - with the prior strong increase in labour force participation associated with graduate education becoming a small increase or even reduction in participation across the demographic subgroups.

The child result is found over the same time period, and using roughly the same data, as previous studies. However, the model specification was different than these prior models with region variables and interaction terms missing. This new specification also produced sizeably lower fixed costs of work for couple males during the HES88-93 to HES01-08 estimates than those found in prior estimates. When children are removed in HES09-13 the fixed cost of work increases substantially, implying that the child variable is relevant for explaining some of the non-participation during the entire time horizon.

The education result stems directly from the relatively poor participation of those with graduate qualifications in the HES09-13 period. Graduate couples males, who experienced the largest graduate work gap, made up over 27.1% of the coupled male sample but only 25.6% of the employed coupled males.

Overall, the reasonable fit to the underlying hours distribution and credible outcomes of the model suggest that these models provide a reasonable starting point for simulations of labour supply outcomes given income shocks to households.

In that vein, the models estimated in this paper will be used to simulate the change in labour supply behaviour by individuals following adjustments in the structure of the tax-transfer system. Such a model takes these preference estimates and calibrates the model to start at the initial set of hours points for each individual. From their changes in net incomes associated with an adjustment in the tax-transfer system are introduced, and these estimated preference parameters indicate how labour supply choices would be expected to adjust.

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