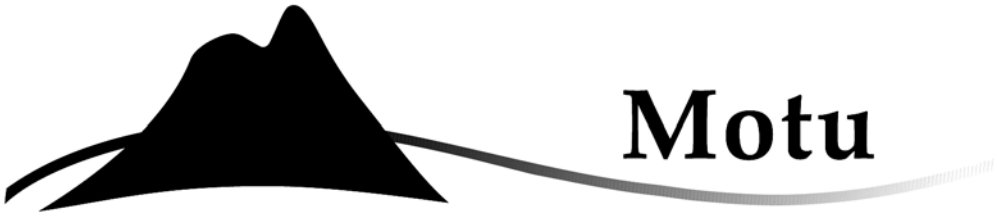

Understanding New Zealand's Changing Income Distribution 1983–98: A Semiparametric Analysis

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Motu Economic and Public Policy Research
Motu Working Paper 2003–16

October 2003

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Acknowledgements
We thank David Card, Ken Chay, Ron Crawford, John DiNardo, Brian Easton, Lesley Haines, Stephen Jenkins, Benedikte Jensen, Jas McKenzie, John Scott, seminar participants at UC Berkeley's labor lunch, Victoria University of Wellington's REF seminar, the New Zealand Association of Economists conference, the NZ Treasury, UCLA, Stanford, the University of Canterbury and GRADE (Lima, Peru), and two anonymous referees for helpful comments and discussions, and Matthew Bell and Ivan Tuckwell for expert assistance with numerous data issues related to the HES survey. 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. Hyslop is grateful for the hospitality and support of the Center for Labor Economics at UC Berkeley. Maré's initial work on the paper was done while he was employed by the New Zealand Department of Labour. Maré acknowledges funding support from the New Zealand Foundation for Research Science and Technology, for the Motu Research programme "Understanding Adjustment and Inequality". Any views expressed are those of the authors and do not purport to represent those of the New Zealand Department of Labour, the New Zealand Treasury or Statistics New Zealand. All mistakes remain the sole responsibility of the authors.

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Abstract

This paper analyses changes in the distribution of equivalised gross household income and income inequality in New Zealand between 1983 and 1998. We analyse the distributional effects of changes in household structure, National Superannuation (old age pension), household socio-demographic attributes and employment outcomes, and in the "economic returns" to such attributes and employment outcomes, using a semiparametric kernel density approach, and assess the impact of these factors on alternative summary measures of inequality over the period. We find that changes in household structure and in the socio-demographic characteristics of households are the main factors contributing to the rise in inequality, while the large changes in the employment outcomes had a more modest impact, and there is little evidence of systematic effects of changes in the economic returns. The results are qualitatively robust to a variety of equivalisation, income, and weighting measures.

JEL classification
D31—Personal income and wealth distribution
C14—Semiparametric and nonparametric methods
I30—Welfare and poverty—general

Keywords
Household income distribution; Inequality; Kernel density estimation

Contents

1 Introduction

There has been a dramatic increase in the degree of income inequality in New Zealand since the early 1980s. This increase was more pronounced than that in the United States and was large enough to move New Zealand from a mid-ranking OECD country to having one of the most unequal income distributions in the OECD.[1] The period of increasing inequality coincided with a period of dramatic economic and social policy reform in New Zealand, which naturally has led to considerable interest in possible links between the two, and to what the New Zealand experience can tell us about the links between inequality and reform.

The New Zealand literature documenting the change has most typically focused on the Gini coefficient as a summary measure of income inequality, and documented increasing inequality across a broad range of alternative income measures.[2] Although the rise in inequality has been well documented, the reasons for the increase are less well understood. Several "reforms"-related hypotheses have been proposed to explain the rising inequality, including the effects of trade liberalisation which have affected domestic industry, hence employment and income; the effects of labour market reform, particularly the Employment Contracts Act (ECA), which reduced support for collective bargaining; and social policy reform, which reduced the generosity of income support for some welfare beneficiaries.[3] However, secular trends in social and demographic factors, such as the population and household age structure and the incidence of sole-parent families, may also have contributed to the change in inequality.[4]

[1] For instance, the Gini coefficient on equivalised disposable income in New Zealand increased from 0.27 in 1982 to 0.33 in 1996; this was similar to the increase in the UK (from 0.28 in 1981 to 0.33 in 1996) and substantially larger than the US (0.34 in 1984 and 1995) and other OECD countries—see Figure 7.2 in Statistics New Zealand (1999).

[2] These include both individual and family or household incomes, measures of market, gross and disposable income, and measures of equivalised and non-equivalised income. For example, see O'Dea (2000), Statistics New Zealand (1999), Podder and Chatterjee (1998), and Martin (1998). Easton (1996) provides a recent evaluation of longer-term trends in income inequality in New Zealand, with a particular focus on the post-1984 period. Dixon (1996, 1998) examined changes in earnings and labour market outcomes of individuals over this period.

[3] See Silverstone et al (1996) for analyses of the effects of a range of policy and economic reforms.

[4] See Davey (1998) and Statistics New Zealand (1998).

This paper investigates the changes in the distribution of household incomes in New Zealand between 1983 and 1998 using data from the Household Economic Survey (HES). The analysis focuses on two issues that distinguish it from previous literature. First and foremost, we focus on the entire distribution of income, rather than simply summary measures of inequality which may be relatively uninformative regarding changes in the income distribution and may be quite sensitive to changes in specific areas of the income distribution. Second, we adapt a semiparametric approach developed by DiNardo et al (1996) to focus on how changes in various sets of factors affect both the overall distribution of income and summary measures of inequality.[5] This approach facilitates a visual appreciation of the factors associated with distributional changes, and can be used to derive summary measures of inequality and the contribution of various factors to changes over the period. We focus on five sets of factors: household structure; the statutory rate of National Superannuation (old-age pension, NS); socio-demographic attributes; employment outcomes; and the economic "returns" to socio-demographic attributes. Although we do not attempt to isolate the distributional impact of any specific policy reform, the analysis provides information on the nature of the distributional changes and the extent to which they were associated with particular sets of observable household attributes. Our concluding comments discuss the implications of our findings for characterisations of the impact of the reform process.

The paper is organised as follows. In the next section we discuss the data and describe the trends in aggregate inequality measures and possible correlates of these trends. In Section 3, we present the empirical framework used to construct counterfactual income distributions under assumptions about changes in each set of factors over time. Using kernel density methods we describe the effects of these changes between the three years at the beginning of the sample period (1983–86) and the three years at the end (1995–98). In Section 4 we use the counterfactual distributions to estimate alternative summary measures of inequality, and use these to decompose the change in inequality over the period into the effects of the various factors we examine. Section 4 also considers the

[5] Also see Daly and Valletta (2000) for a recent analysis of wage and income inequality in the US.

robustness of the results to four issues: the ordering of the sequential decomposition; alternative equivalised income measures; heterogeneity of effects over household types; and sub-period changes. The paper concludes with a discussion in Section 5.

We find that changes in household structure can account for between 10% and one-third of the observed changes in the household income distribution and inequality, depending on the specific measure used. In addition, changing socio-demographic attributes of households can account for a similar fraction of the observed changes. Somewhat surprisingly, the substantial changes in employment over the period had relatively modest effects on overall income inequality; however, these changes did have a larger effect on inequality measured at the household-type level. Although changes in NS play a prominent role in localised changes in the distribution, this factor contributes relatively little to changes in broad measures of inequality, largely due to offsetting changes for singles and couples. Finally, we find no systematic effects of changes in economic returns to attributes on the household income distribution and inequality.

2 Data and descriptive analysis

This section describes the data that we use, and presents an overview of the trends in household income inequality and other factors of interest over the sample period. The data come from Statistics New Zealand's Household Economic Surveys (HES, formerly known as the Household Expenditure and Income Survey) over the period 1983–1998. The HES is a household-based survey which samples approximately 3,000 households annually, from April to March, and collects information on the household structure, socio-demographic characteristics and relationships of individuals in the household, together with income from various sources and some basic labour market information on individuals. For the first three years of the period (1983/84–1985/86), the sample frame used for the HES was a simple random sample of households; for the later

years (1986/87–1997/98), a stratified random sample of households was drawn in each year.[6]

The "family" is the basic unit within which the welfare of individuals in general and children in particular is assessed, and disposable income is the preferred measure of current resources available. However, for measurement reasons, our analysis focuses primarily on household gross reported cash income.[7] We adjust household income relative to a two-person household using the Luxembourg (0.5) equivalence scale, which divides income by the square root of one-half of the number of individuals in the household, and adopt the individual as the unit of analysis by weighting the data using the HES household sampling weight multiplied by the number of individuals in the household.[8] In Section 4 we examine the robustness of the results to these various choices, and consider measures of disposable income, and alternative equivalence scales and units of observation. Nominal gross incomes are adjusted to 1999 dollar values using the Consumers Price Index (CPI) that excludes the effects of the Goods and Services Tax (GST), while nominal disposable incomes are adjusted using the CPI including GST effects.[9] In order to lessen the effects of outliers, and to facilitate graphical presentation, we have left- and right-censored equivalised income at seven log-points (approximately $1,100) and 12.25 log-points (approximately $209,000) respectively: this affects 1% of low incomes and 0.6%of high incomes.

[6] The stratification is by region, rural/urban, and by ethnicity (Māori in most strata, and Pacific Islands Polynesians in Auckland and Wellington).

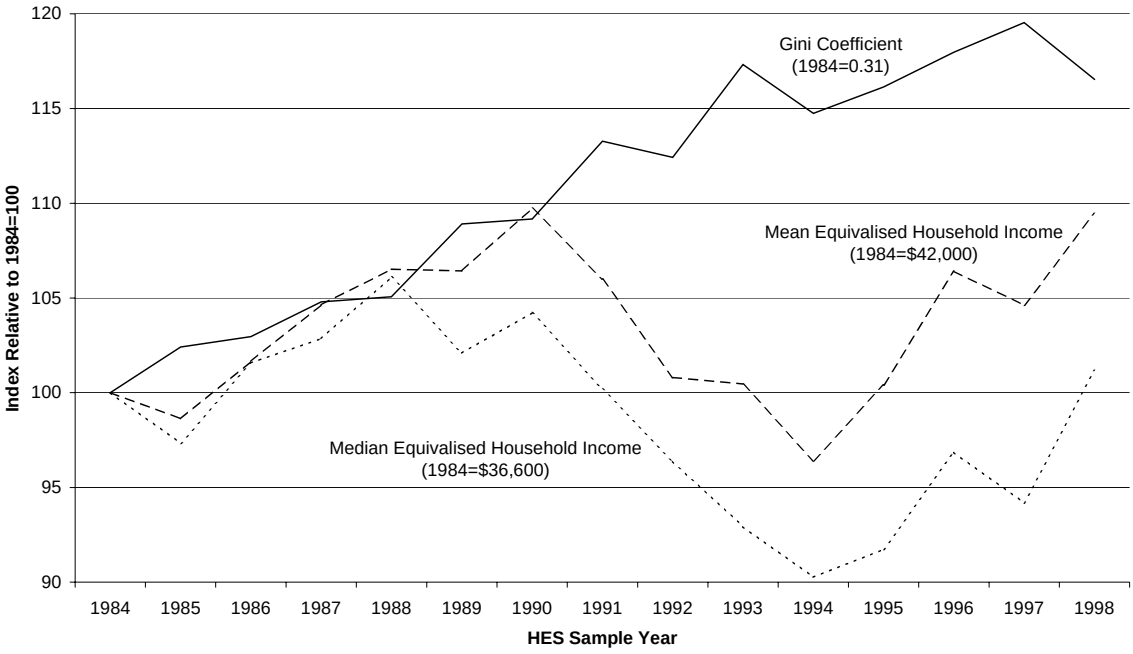
[7] Households are empirically better defined than families. If unrelated individuals share the same household (e.g. flatmates), this will tend to overstate the resources available to individuals; on the other hand, if individuals receive support from outside the household (e.g. students living away from home), this will tend to understate resources available to individuals. Estimating household disposable income accurately requires detailed information on the relationships of individuals in the household, together with knowledge of tax and rebate eligibility and the relevant take-up propensities. In addition, annual incomes reported in the HES pertain to twelve-month periods that do not in general correspond to tax years.

[8] See, for example, Danziger and Taussig (1979), Jenkins (1991), and Jenkins and Cowell (1994) for discussions of alternative equivalence scales. One reasonably flexible approach is to equivalise income (Y) as $E = Y/(\lambda(N_A + \kappa N_C))^{\sigma}$, where $1/\lambda$ identifies the base household size, N_A and N_C are the numbers of adults and children in the household respectively, and σ captures the economies of scale associated with household size. The Luxembourg (0.5) scale adopted uses $\lambda = 0.5$, $\kappa = 1$ and $\sigma = 0.5$.

[9] A 10% rate of GST was introduced on 1 October 1986, and increased to 12.5% on 1 July 1989. We have used a CPI (ex GST) series estimated by the Reserve Bank of New Zealand. Given the substantial changes in the tax and benefit regimes in the late 1980s, it is not obvious what is the best method to adjust the nominal reported incomes in the HES to constant-price values. We believe that a GST-exclusive adjustment is more suitable for gross market incomes, while a GST-inclusive adjustment is more suitable for disposable incomes.

Figure 1 describes the trends in the mean, median and Gini coefficient of equivalised household income from the HES for each year from 1983/84–1997/98, with each series indexed to 100 in 1983/84. This figure reveals some interesting relationships between the level and dispersion in incomes over the period. First, mean equivalised income increased about 10% between 1983/84 and 1989/90, then fell nearly 15% during the first half of the 1990s before rising again for a (net) 10% increase over the period. Median incomes increased about 6% until 1988, and then fell 15% though until 1994, before rising again to finish with a 1% net gain over the period. These differences suggest that higher incomes rose quite strongly, while lower and middle incomes rose, at best, only modestly over the period. Second, the Gini coefficient increased nearly 15% between 1983/84 and 1990/91, and continued to rise modestly during the 1990s.

Figure 1: Relative change in household income levels and inequality: 1983/4–1997/8



We use aggregated three-year HES samples corresponding to the beginning (1983–86), middle (1989–92) and end (1995–98) of the period in order to increase the period-specific sample sizes to improve the reliability of the subsequent analysis. Although this means that point-in-time estimates of the income distribution will be susceptible to year-to-year changes within each period, Figure 1 suggests the bulk of the changes over the sample period occurred

between rather than within the three sub-periods that we analyse. Table 1 presents the sample characteristics for each of these three-year periods. There are several changes worth noting in Table 1 that potentially affect the income distribution and inequality. Note, first, the change in household structure as characterised by the number and age of adults, and the presence or absence of children, in the household.[10] The most salient changes in household structure are the decline in the fraction of individuals living in multiple adult with children households (e.g. two-parent families), from 58% in 1983–86 to 50% in 1995–98, and the increase in the fraction living in single adult with children households, from 4 to 7%. In addition to these changes, the fractions of individuals living in households without children increased modestly over the sample period. To the extent that the income distribution varies with household structure, these changes in household structure will have an impact on the overall distribution of household income and hence inequality over the period.

[10] In particular, we distinguish between single- and multiple-adult households, between households with and without children and, for households without children, between those with adults under and over 60. The age criterion is intended to distinguish between predominantly "retired" and working-age households. For multiple adult households, we have classified the household as "over 60" if the age of the eldest adult is over 60 and either (i) all adults are over 50; or (ii) the fraction of total household income from NS is at least 50%. Otherwise we have classified the household as "under 60". The eligibility age for NS was 60 until 1991, and increased to 65 at the rate of 0.5 year annually. Although this affected the retirement behaviour of those in their early 60s (e.g., see Coleman and Hansen, 1996, and Frame, 1999), we maintain a fixed age criteria over the sample period to separate households.

Table 1: Sample characteristics

	1983–86	1989–92	1995–98
Mean equivalised income	42,044	44,326	44,867
	(276)	(404)	(420)
Median equivalised income	36,496	36,804	35,703
Gini coefficient	0.316	0.346	0.366
No. persons	3.73	3.52	3.52
	(.03)	(.03)	(.02)
No. adults	2.30	2.25	2.21
	(.01)	(.01)	(.01)
Age of adults	39.28	40.89	41.39
	(.12)	(.16)	(.15)
Fraction of adults: [a]			
Female	0.52	0.53	0.54
	(.002)	(.002)	(.003)
Married	0.69	0.64	0.68
	(.004)	(.005)	(.005)
Māori[b]	0.08	0.10	0.11
	(.003)	(.004)	(.004)
School qualifications[c]	0.24	0.32	0.33
	(.004)	(.005)	(.005)
Vocational qualifications[c]	0.23	0.25	0.25
	(.004)	(.005)	(.005)
University qualifications[c]	0.09	0.09	0.14
	(.002)	(.003)	(.004)
Employed full-time	0.58	0.47	0.48
	(.003)	(.004)	(.004)
Employed part-time	0.09	0.13	0.15
	(.002)	(.003)	(.003)
Fraction of households:			
Single adult over 60	0.037	0.045	0.042
Multiple adults over 60	0.027	0.032	0.034
Single adult under 60	0.094	0.110	0.099
Multiple adults under 60	0.226	0.231	0.251
Single adult with children	0.040	0.061	0.072
Multiple adults with children	0.577	0.521	0.503
Number of households	10,578	9,296	8,698

Notes:Standard errors are in parentheses. All means are weighted by the HES household sample weights multiplied by the number of persons in the household. Thus, estimates are equivalent to one observation per person. Incomes are measured in constant (1999) dollars.

[a] Adults are defined as those persons aged at least 18 or aged 15–18 with positive wage and salary or benefit income.

[b] In the years after 1992, up to three ethnic groups could be selected. In this period "Māori" is coded if any of the three ethnic groups are Māori—the fraction of "only Māori" in 1995–98 is 0.06.

[c] Based on "working-age" households only.

Second, Table 1 shows there was a substantial decline in full-time employment during the mid to late 1980s; and, although there was some pickup in the 1990s, the fraction of adults employed full time was 10% lower in 1995–98 than in 1983–86. Part of this decline in full-time employment is made up by an increase in part-time employment: the incidence of part-time employment grew substantially, from 9 to 15%, over the period. To the extent that (un)employment is not evenly distributed across households, these findings suggest that employment loss may help explain the rise in income inequality, given the importance of labour earnings to household income.

Third, Table 1 also reveals some large changes in the socio-demographic attributes of households. Education levels increased substantially over the period: the fraction of adults with School qualifications increased from one quarter to one third, and those with University qualifications increased from 9 to 14%. In addition, the population was ageing: the average age of adults increased more than two years over the period. Each of these factors may influence the distribution of income over the period. As with the rise in inequality shown in Figure 1, Table 1 suggests that such changes tended to be concentrated in the late 1980s.

3 Changes in the equivalised household income distribution between 1983–86 and 1995–98

In this section we develop an empirical framework to examine the influence of the several factors on the distribution of income. The analysis uses and extends a semiparametric conditional density estimation framework developed by DiNardo et al (1996). This framework has several features. First, it allows an assessment of the entire distribution of household income at a given point in time, and changes in the distribution over time, as well as summary measures of inequality. Second, it facilitates the sequential construction of counterfactual distributions for changes in various sets of factors. The sets of explanatory factors we focus on are household structure, socio-economic attributes of households, employment outcomes of households, and the economic "returns" to attributes. Third, these counterfactuals enable the changes in the distribution and in alternative summary measures of inequality to be decomposed

into changes due to such factors. We will describe the effects of changes in the set of explanatory variables on the distribution of household income here, and leave the decomposition of changes in inequality measures until the next section.

We begin by describing the distribution of equivalised household income in the HES samples in 1983–86 and 1995–98 (represented by t = 0 and t = 1 respectively). Specifically, we estimate the probability density, $f_t(y)$, associated with log household income y in time period t, using kernel density methods. If $(y_{t1}, ..., y_{tN})$ is a random sample of N observations in period t, with sampling weights $(\theta_{t1}, \ldots, \theta_{tN})$ ($\sum_{i=1}^{N} \theta_{ti} = 1$), the kernel density estimate of $f_t(y)$ is

$$\hat{f}_t(y) = \sum_{i=1}^{N} \frac{\theta_{ti}}{h} . K\left(\frac{y - y_{ti}}{h} \right) \qquad (1a)$$

where h is the bandwidth, and K(.) is the kernel function. Throughout the analysis, we estimate densities at 250 equi-spaced log income values between seven and 12.25, using a fixed bandwidth h = 0.05, and the Epanechnikov kernel ($K(z) = 0.75((1-z^2)/5)/\sqrt{5}$, if $|z|<\sqrt{5}$; and K(z) = 0, otherwise).[11]

Figure 2a presents the kernel density estimates of the distributions of equivalised household incomes over the 1983–86 and 1995–98 periods. (The horizontal axis is on a logarithmic scale.) Although the 1983–86 distribution is asymmetric, as evidenced by the median being lower than the mean, with distinct shoulders around $19,000 and $25,000, it is broadly bell-shaped with a peak around $40,000. In contrast, the 1995–98 distribution of equivalised income is distinctly bi-modal around $21,000 and $43,000. A comparison of these two income distributions shows that there has been a substantial hollowing-out of the middle of the distribution between $25,000 and $60,000 (the fraction in this range

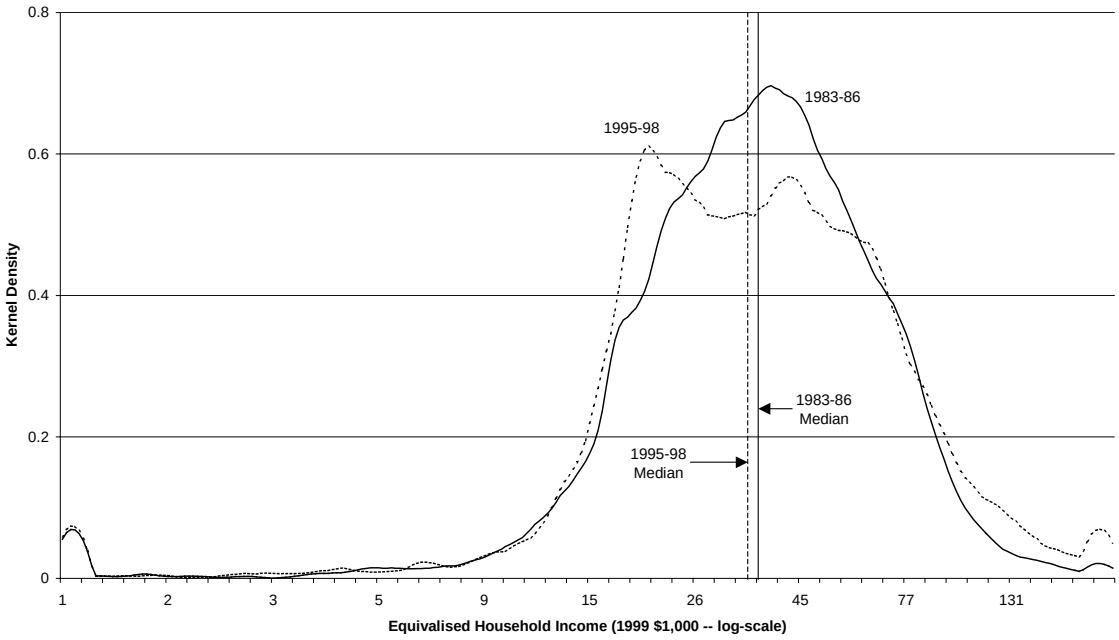
[11] Holding constant the bandwidth, kernel and evaluation points ensures that the overall distribution is equal to the weighted sum of estimated sub-distributions. To facilitate comparison of densities, we use the same evaluation points for all analyses. This choice precludes the use of adaptive bandwidths. For the full samples, the "optimal" bandwidth, which assumes that the underlying distribution is smooth, unimodal, and symmetric, is about 0.09, and this increases as we use subsamples. However, if these assumptions are not valid, then the estimated optimal bandwidth will tend to "over-smooth" the distribution and disguise localised peaks and troughs. As a partial check on the robustness of the results to the choice of bandwidth we have re-estimated some of the distributions using wider bandwidths and found the results are qualitatively unchanged.

fell from 53.2% in 1983–86 to 44.6% in 1995–98), and increases in mass between $12,000–$25,000 (from 23.3% to 28.1%) and above $80,000 (from 7.7% to 11.5%). These shifts are perhaps even more apparent from Figure 2b, which shows the estimated change in the density of the income distribution at each real income level y:[12]

$$\Delta\hat{f}(y) = \hat{f}_1(y) - \hat{f}_0(y). \qquad (1b)$$

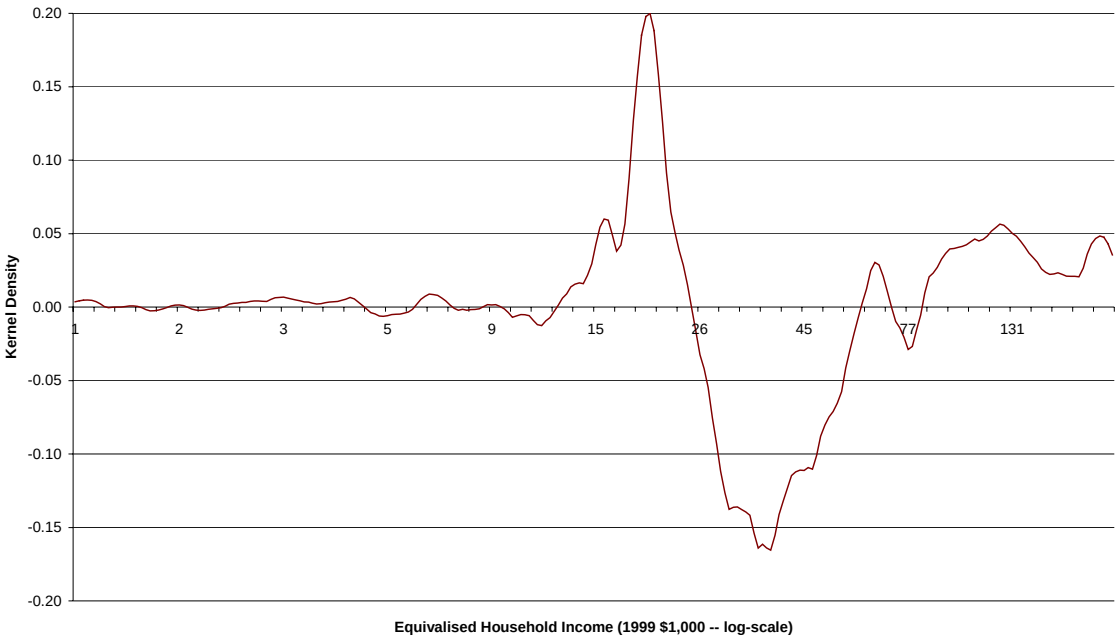
Finally, note that the small peaks in the tails of the distributions in Figure 2a reflect the left- and right-censoring in the data.

Figure 2a: Distribution of equivalised household gross income: 1983–86 and 1995–98



[12] In order to verify that the observed changes are not simply due to sampling variation, we calculated bootstrap standard errors of the kernel density estimates and the changes, using 100 replications. The main changes observed were found to be statistically significant at conventional levels. Hyslop and Maré (2001) presents the same graphs with confidence interval bounds on the density estimates and contains further details.

Figure 2b: Changes in distribution between 1983–86 and 1995–98



3.1 Decomposing changes in the income distribution

We now turn to the second feature of the analytical framework, which is to provide a decomposition of the overall change in the distribution of household incomes due to various sets of factors. We adopt a sequential counterfactual approach to analysing the effects of each set of factors.[13] Each counterfactual involves either a *reweighting* of the sampling weights for each household (for household structure, socio-demographic attributes, and employment outcomes) or a *rescaling* of income (for NS and economic returns).[14] The first and second columns in Table 2 summarise the adjustments made to the income or weight for each counterfactual, while the appendix contains further details of the constructions. The third column contains an informal summary statistic of the change in the equivalised income density between 1983–86 and 1995–98 attributable to each factor. These statistics are based on the correlations

[13] In order to examine the robustness of the results based on the particular sequential ordering chosen here, we have repeated the analysis for all possible orderings. The results are reported in Section 4.

[14] We use more or less the same set of covariates to generate the counterfactual distributions for the effects associated with changing attributes, employment and returns. The attributes and employment counterfactuals therefore rely on different non-linear effects of these covariates on the sampling weights, while the returns counterfactual relies on the effects of these covariates on incomes.

between the actual density change and the (marginal) changes predicted by each factor. For each factor, it is the coefficient from the regression of that factor's predicted marginal density change on the actual density change over the period. These measures have the attractive accounting feature that they sum to one across the set of explanatory (and unexplained) factors, so can be interpreted as the fraction of change attributable to each factor.

To begin, note that the overall distribution of household income is simply the weighted average of the sub-distributions for each different household type, where each sub-distribution is weighted by the fraction of the population living in that group. That is, if w_{tj} is the weighted fraction of individuals in household type j in period t,[15] and $f_{tj}(y)$ is the probability density of log equivalised income y for household type j in period t, then the overall household income distribution can be expressed as

$$f_t(y) = \sum_{j=1}^{6} w_{tj} f_{tj}(y) \tag{2}$$

In order to illustrate the contributions of the income distributions of the six household types to the overall distribution, we estimate the densities of equivalised income for each of the six household groups in 1983–86 and 1995–98, $\hat{f}_{tj}(y)$, using the same bandwidth and kernel as described for the overall distribution in Equation (1a), and weight each by its sample fraction, w_{tj}. Figures 3a and 3b plot these weighted sub-distributions for the 1983–86 and 1995–98 periods respectively, together with the overall distributions of household equivalised income (as shown in Figure 2a).

[15] The weighted fraction of households in household type j is simply the sum of the sampling weights for households in type j: $w_{tj} = \sum_{i=1}^{N_{tj}} \theta_{ti}$, where N_{tj} is the number of type j households in period t.

Table 2: Counterfactual incomes and weights, and contributions to density change

Distribution	Income measure	Conditioning weight	Contribution to density change
1. Base period (t = 0) actual distribution	y_{0i}	θ_{0i}	
2. Changes in household type[(a)]	y_{0i}	$\hat{\theta}_{0i}^{H} = w_{1ji}/w_{0ji}.\theta_{0i}$	0.176
3. Changes in NS[(b)]	$\hat{y}_{0i}^{N} = \log(Y_{0i} + (\pi_i\text{-}1)\, Y_{0i}^{N})$	$\hat{\theta}_{0i}^{H}$	0.096
4. Changes in socio- demographic attributes[(c)]	$\hat{y}_{0i}^{N}$	$\hat{\theta}_{0i}^{XH} = \hat{\psi}_{xj}(x_{0i}).\hat{\theta}_{0i}^{H}$	0.092
5. Changes in employment[(d)]	$\hat{y}_{0i}^{N}$	$\hat{\theta}_{0i}^{EXH} = \hat{\psi}_{e\|x,j}(e_{0i}, x_{0i}).\hat{\theta}_{0i}^{XH}$	0.200
6. Changes in economic returns[(e)]	$\hat{y}_{0i}^{RN} = \hat{y}_{0i}^{N} + X'_{0i}(\hat{\beta}_{1j} - \hat{\beta}_{0j})$	$\hat{\theta}_{0i}^{EXH}$	0.018
7. Final period (t = 1) actual distribution	y_{1i}	θ_{1i}	

Notes: The entries in the first and second columns describe the income measures and weights used in constructing the kernel density estimates of the various income distributions, where Y_{ti} is the equivalised gross income of household i in period t, $y_{ti} = \log(Y_{ti})$, and θ_{ti} is the sampling weight for that household (equal to the household's sampling weight multiplied by number of people in the household). Each household i has a household type j. The j subscript is suppressed except where household type is important. The entries in the third column are estimated as coefficients from regressions of the kernel density changes attributable to each factor on the total density changes between 1983–86 and 1995–98.

(a) $w_{tj} = \sum_{i \in H_j} \theta_{ti}$ is the weighted fraction of households in type j in period t.

(b) $\pi_i = NS_{1i}/NS_{0i}$, where NS_{ti} is the *rate* of NS applicable to household i in period t; and Y_{0i}^{N} is the actual NS income of household i in period 0–see text and Appendix for details.

(c) The reweighting to adjust for changes in socio-demographic attributes (x) between period 0 and 1 is $\hat{\psi}_{xj}(x_{0i}) = \frac{P_j(t=1 \mid x_{0i})}{P_j(t=0 \mid x_{0i})}.\frac{P_j(t=0)}{P_j(t=1)}$, where $P_j(.|x)$ is estimated using a Logit model for the period of observation and $P_j(t = 1)$ is the fraction of the sample in period 1–see text and Appendix for details.

(d) The reweighting to adjust for changes in employment outcomes between period 0 and period 1 is $\hat{\psi}_{e|x,j}(e_{0i}, x_{0i}) = \sum_{m=0}^{M_j} e_{m0i}.\frac{P_{1j}(e_m = 1 \mid x_{0i})}{P_{0j}(e_m = 1 \mid x_{0i})}$, where $P_{tj}(.|x)$ is estimated using an Ordered Logit model for the employment outcomes–see text and Appendix for details.

(e) $\hat{\beta}_{tj}$ are the estimated coefficients from median regressions of $\hat{y}_{0i}^{N} = X_{ti}'\beta_{tj} + \varepsilon_{ti}$.

Figure 3a: Distribution of household incomes 1983–86: Contributions by household type

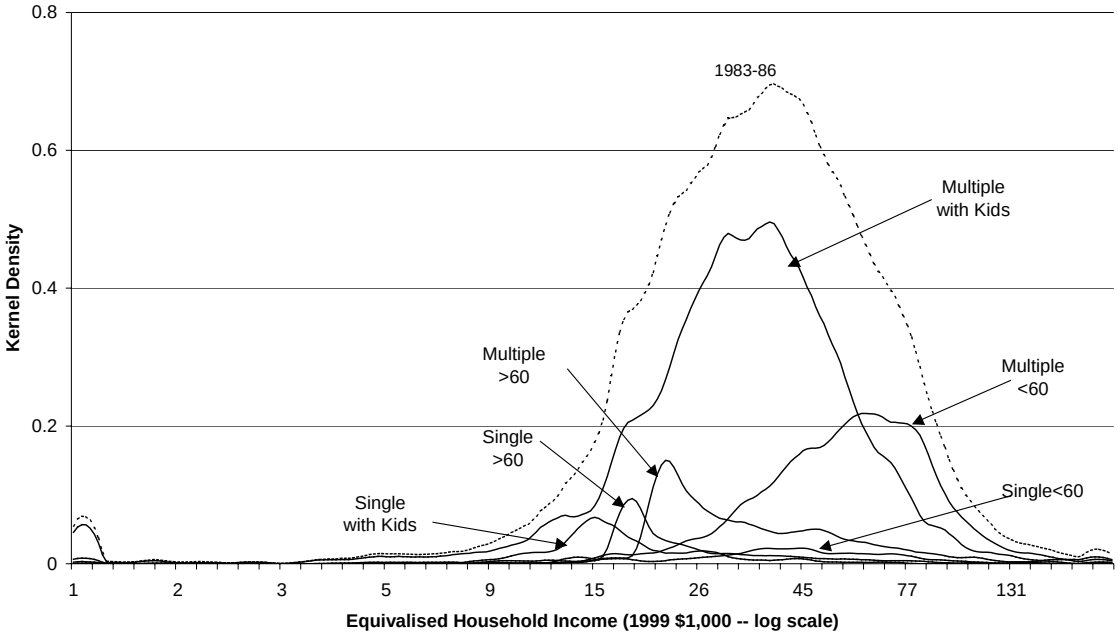
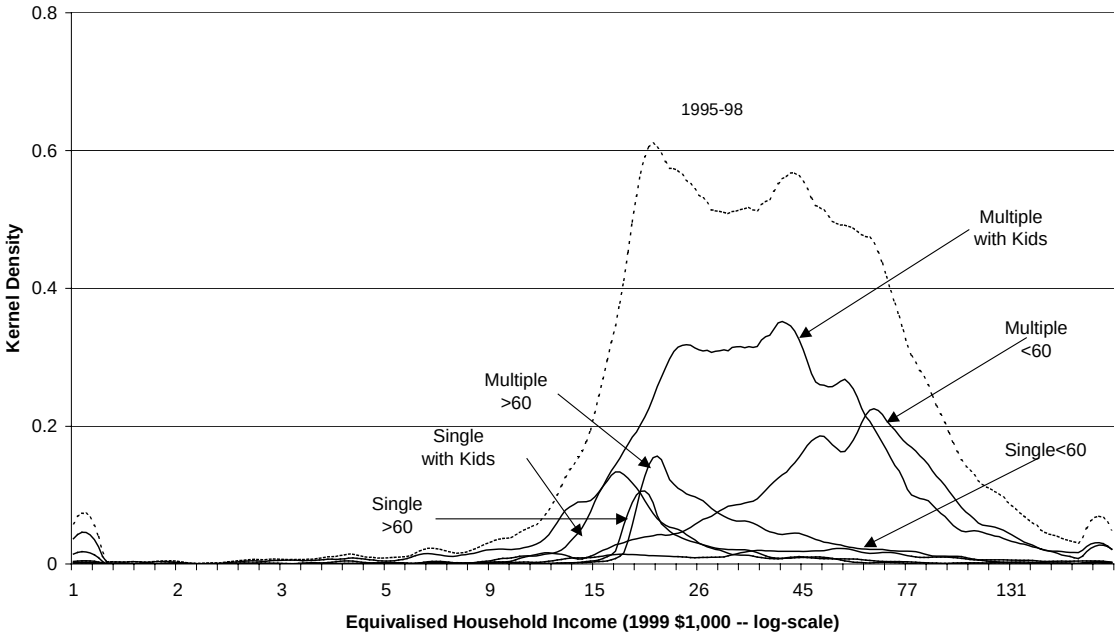


Figure 3b: Distribution of household incomes 1995–98: Contributions by household type



It is apparent from Figures 3a and 3b that, as well as the relative contributions of each household type varying according to the distribution of households, the equivalised income distributions across the household types also differ substantially. In particular, multiple-adult households tend to have higher equivalised incomes than single-adult households; households with children tend to have lower equivalised incomes than households without children—i.e. compare the multiple-adult households with and without children, and the single-adult households with and without children; and "over-60s" households tend to have lower incomes than "under-60s" households.

Furthermore, the relative positions of the distributions for the different household types are suggestive of the explanations for the shape of the overall distribution of income. For example, although only 4% of individuals live in single-over-60s households, in 1983–86 they are concentrated in the region of the left-most shoulder in the overall distribution, suggesting that NS for single people contributes strongly to this region. Similarly, the distribution for the multiple-over-60s households is concentrated around the second shoulder of the overall distribution, suggesting that NS for married couples contributes strongly to this region. Households at the main peak in the income distribution (around $25,000–$50,000) are mainly multiple-adult households (with and without children). The drop in the fraction of individuals in multiple adult households, together with the increasing dispersion in the equivalised income distributions of these households, contributes to the flattening out of the distribution in this range.

The remainder of this section provides a general description of the methods that we use to decompose changes in the income distribution. A more detailed exposition of the methods used is included in the appendix.

3.2 Changes in household structure

The contribution of changes in the distribution of household types in the population to changes in the overall distribution of income depends on how changes in the distribution of households affect different points in the income distributions of the various household types. For example, the impact on the overall distribution of income will be different if the drop in two-parent families is due to a drop in low-income families rather than to a drop in high-income families. We adopt the neutral assumption

that such change occurs randomly across the respective household-type distributions,[16] which implies that the income distributions for each household type remain unchanged between 1983–86 and 1995–98. This counterfactual distribution involves simply reweighting the 1983–86 income distributions of each household type by the 1995–98 household-type fractions, and is estimated by

$$\hat{f}_0^H(y) = \sum_{j=1}^{6} w_{1j}\,\hat{f}_{0j}(y) \qquad (3a)$$

Figure 4a plots this counterfactual distribution together with the actual 1983–86 distribution of equivalised income. The shape of these two distributions is very similar. The counterfactual distribution has somewhat less mass in the middle-income range than the actual distribution and greater mass in the lower-income range, reflecting the effects of the shift away from multiple-adult with children households towards sole-parent and single-adult households over the period. Under this counterfactual, the observed changes in the household structure over the 1980s and 1990s would be expected to cause a downward shift in the distribution of income. We emphasise this effect in Figure 5a, which graphs the estimated difference between this counterfactual distribution and the actual 1983–86 distribution:

$$\Delta\hat{f}^H(y) = \hat{f}_0^H(y) - \hat{f}_0(y) = \sum_{j=1}^{6}\left(w_{1j} - w_{0j}\right)\hat{f}_{0j}(y) \qquad (3b)$$

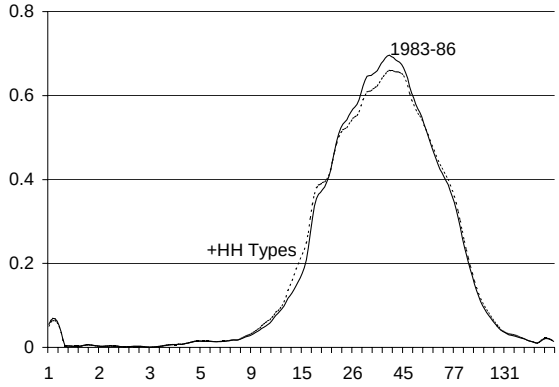
together with the estimated total difference between the actual 1983–86 and 1995–98 distributions, described by Equation 1b.

Figures 4a and 5a suggest that the changing distribution of household types provides a partial and important explanation for the observed changes in the distribution of household income over the period. For example, the density changes attributable to changing household types account for 18% of the total density change (see Table 2). Given that the predicted shift is from the middle-income range to the left hand tail, this is likely to translate into an increase in income inequality. We return to this issue in the next section. First, we consider the effects of factors that might affect the distribution of income within household types.

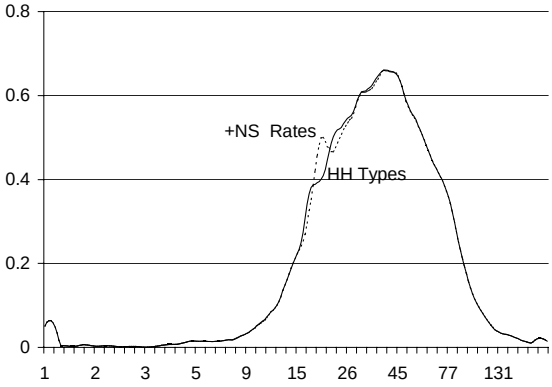
[16] If only the distribution of households in the population changed during the period, the income distribution for each household type would be unchanged and the counterfactual distribution for changes in the distribution of households would exactly match the actual distribution of income in 1995–98. We subsequently allow for changes in socio-demographic attributes and employment outcomes of households.

Figure 4: Counterfactual distributions

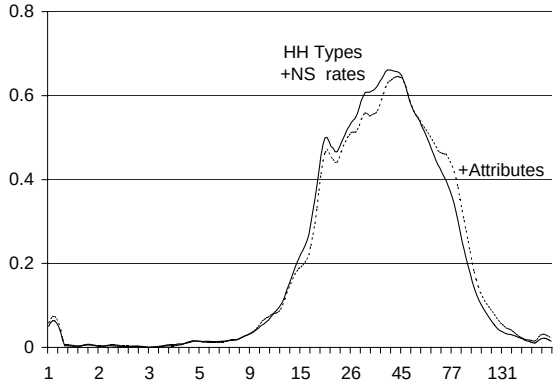
(a) Household types



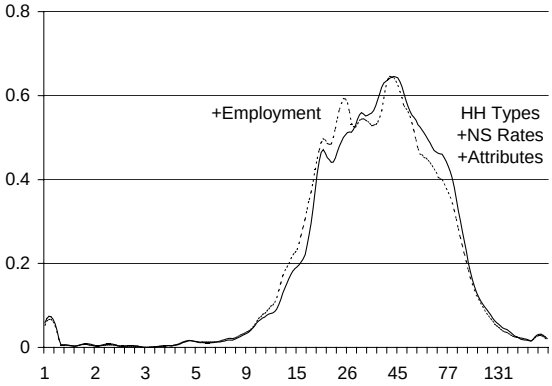
(b) NS



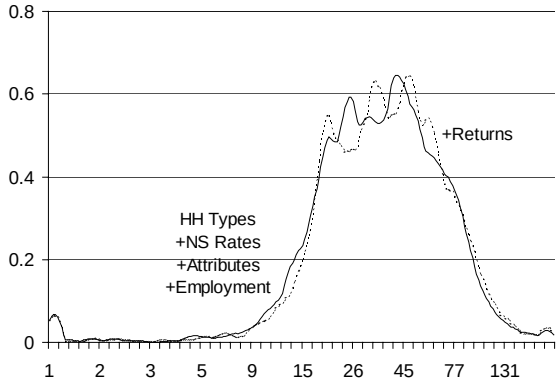
(c) Socio-demographic attributes



(d) Employment outcomes



(e) Economic returns



(f) All explanatory factors

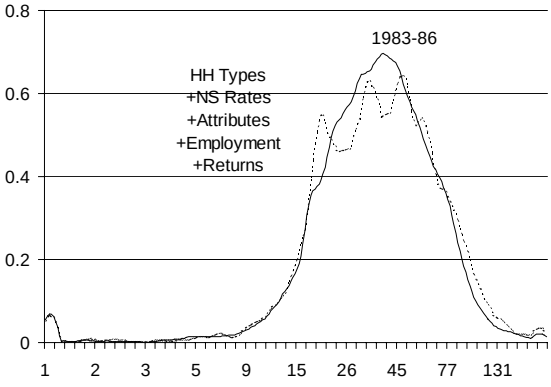
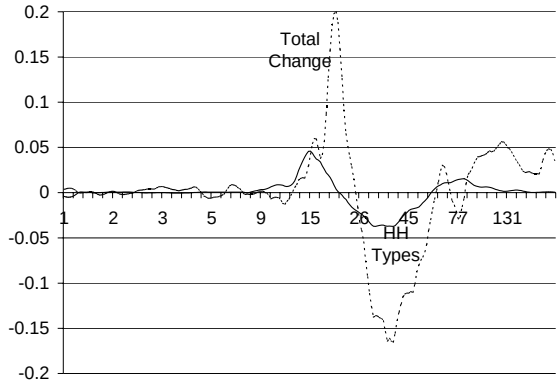
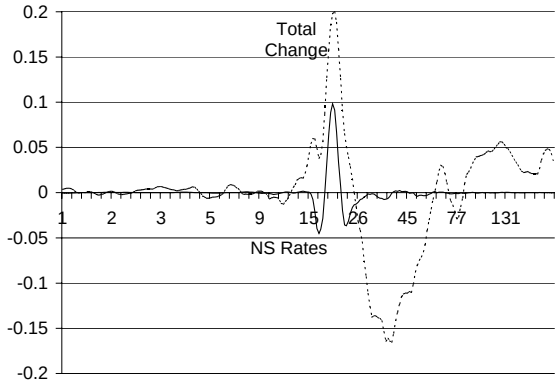


Figure 5: Counterfactual distribution changes

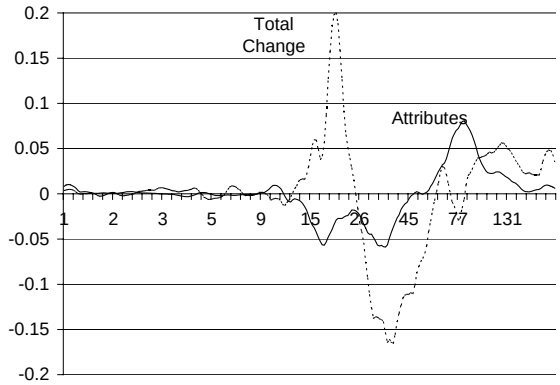
(a) Household types



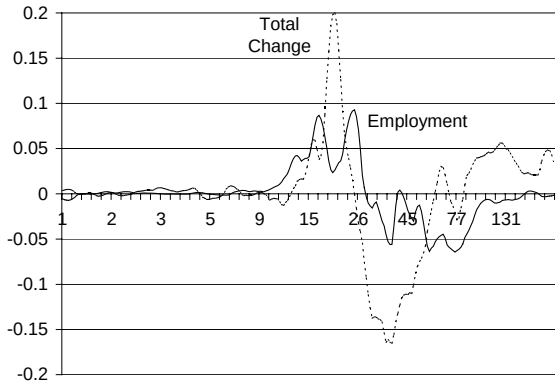
(b) NS



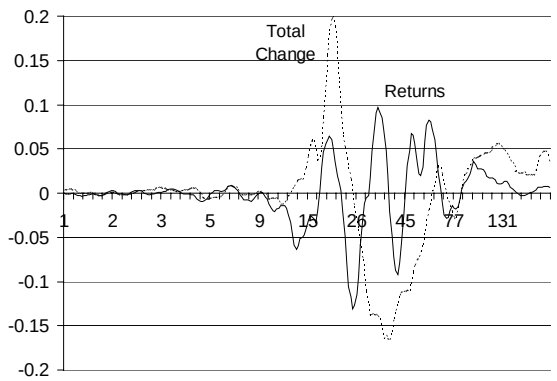
(c) Socio-demographic attributes



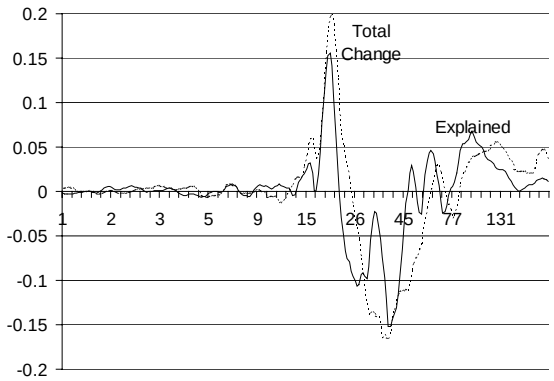
(d) Employment outcomes



(e) Economic returns



(f) All explanatory factors



Notes: Each panel shows the total change for the period and the marginal contribution of the listed factor.

3.3 National Superannuation changes

Given the apparent contribution of retired households to the two lower shoulders in the equivalised income distributions in Figures 2a and 2b, it is intuitive to consider the effects of changes in the statutory rates of NS.[17] Although in principle this analysis could be extended to all welfare benefits, other non-age related welfare benefits are less easily identified in the data, experienced a myriad of different rate changes, and play a less apparent role.

The counterfactual distribution to take account of changes in the NS rates involves a translation of the income of households. First, we construct separate indexes for the statutory rates for singles and couples between 1983 and 1998 (adjusted for CPI ex-GST changes). Second, for each household in 1983–86, we adjust the NS component of income to the 1995–98 value, using the single-rate index if the household has a single person aged over 60, and the couple-rate index if the household has two or more members aged over 60.[18] We then compute the 1995–98 counterfactual total household income by adding this adjusted NS to the other actual income received by the household in 1983–86. This provides an estimate of the level of income the household would have received in 1995–98 given their 1983–86 NS and other incomes and the NS statutory-rate changes over the period. Third, we estimate the kernel density of the overall counterfactual household equivalised income distribution, $\hat{f}_0^{NH}(y)$, by weighting the household type counterfactual sub-distributions, $\hat{f}_{0j}^{N}(y)$, analogously to Equation 3a. The marginal change in the distribution explained by these statutory NS rate changes, conditional on changes in household types, $\Delta\hat{f}_0^{N}(y)$, is estimated, analogously to Equation 3b, as the difference between $\hat{f}_0^{NH}(y)$ and $\hat{f}_0^{H}(y)$.

[17] The impact of NS is much more apparent in the unequivalised household income distributions, where it contributes to two large spikes in the distributions corresponding to the single and couple rates. Furthermore, these spikes move in opposite directions over the period as the statutory National Superannuation rates for singles and couples changed by 5.8% and –5.4% respectively. That these spikes move in opposite directions suggests that the changes are not simply due to the CPI adjustment used. See Hyslop and Maré (2001) for the details of this analysis.

[18] As expected, the vast majority of NS is paid to "Single adult over 60" households and "Multiple adult over 60" households with just two members. However, a small fraction of households in the latter group have more than two members over 60 (0.9%). Similarly, a small fraction of working-age households, largely in the "multiple adults under 60" group, also receive NS (3.8%).

Figure 4b shows the counterfactual distributions, $\hat{f}_0^{NH}(y)$ and $\hat{f}_0^{H}(y)$, while Figure 5b shows the marginal change in the income distribution due to NS, $\Delta\hat{f}_0^{N}(y)$, together with the total change over the period. As expected, the effects of controlling for changes in NS are concentrated in the lower half of the income distribution, and generate a localised peak in the distribution in the affected region. Figure 5b shows that these changes contribute much of the distributional change around this spike. As this factor explains the bulk of the income distribution changes for the two "retired" household groups, we exclude these groups from the subsequent analyses. Using our informal measure of contribution, the density changes attributable to changing NS rates account for 10% of the total density change.

3.4 Changes in socio-demographic attributes

The third effect we consider is changes in the socio-demographic attributes of households. Changes in attributes allow us to control for non-random changes in observable characteristics within the distribution of household types over time, and may affect the distribution of income, irrespective of any changes in household structure. For example, human capital factors, such as education and experience, may directly affect individual incomes and hence the level of family or household income. Similarly, fertility decisions and other life cycle factors may affect labour supply choices and household income. Table 1 shows that there were increases in qualifications as well as average age during the period, the impact of which are picked up in this stage of the analysis.

The counterfactual distribution for the effects of changing attributes is constructed as follows. For each of the four working-age household types, we estimate the relationship of how the household attributes vary between 1983–86 and 1995–98, adopting flexible specifications which vary across each household type. The attributes we use include the number, age, sex, ethnicity, and education levels of adults in the household, together with the numbers of children in various age groups.[19] This estimated relationship is used to adjust the 1983–86 households' sampling weights to reflect the change in attributes in 1995–98: this reweighting gives greater weight to

[19] Appendix tables A1(a)–A1(d) contain the estimation results for these specifications for each of the household types, together with those for the employment outcomes and economic returns discussed below.

1983–86 households with attributes more similar to those in 1995–98 and less weight to households whose attributes are less similar. For each household type, we construct a counterfactual distribution, $\hat{f}_{0j}^{XN}(y)$, using these attribute "reweights", and then construct the counterfactual distribution for all households, $\hat{f}_{0}^{XNH}(y)$, as a weighted average of the household types counterfactual distributions, using final period household type shares w_{1j}. The estimated marginal change in the distribution attributable to the change in attributes, $\Delta\hat{f}_{0}^{X}(y)$, is the difference between the counterfactuals, $\hat{f}_{0}^{XNH}(y)$ and $\hat{f}_{0}^{NH}(y)$.

Figure 4c shows the counterfactual distributions which include and exclude changes in attributes, $\hat{f}_{0}^{XNH}(y)$ and $\hat{f}_{0}^{NH}(y)$. Figure 5c displays the marginal effect of changing attributes on the equivalised income distribution, $\Delta\hat{f}_{0}^{X}(y)$, together with the total change over the period. Broadly speaking the observed changes in attributes are predicted to cause an upward shift in mass in the income distribution. For example, there is a (net) drop in individuals with household equivalised incomes in the $12,000–$47,000 range, balanced by a net gain in the proportion of individuals with equivalised income above $56,000. As the shift in mass predominantly occurs from the middle to the right hand tail of the distribution, the changing socio-demographic characteristics of households is likely to cause an increase in income inequality. The density changes attributable to changing household attributes account for 9% of the total density change.

3.5 Employment outcomes

Given that the majority of individual and household income comes from labour earnings, the employment outcomes of individuals and their households has a major impact on the distribution of household equivalised income. Furthermore, the dramatic changes in employment that occurred during the late 1980s suggest that the changes in employment may have important implications for the observed changes in the distribution of income. We investigate these issues as follows.

For working-age households, we categorise employment outcomes into either three (for single-adult households) or five (for multiple-adult households) discrete

groups on the basis of the number of full-time and part-time workers in the household.[20] Ordered logit models for the relationship between the employment outcome and household attributes are then estimated separately for each period and each household type. We predict the employment outcome of each 1983–86 household given its set of attributes using the estimated 1983–86 and 1995–98 relationships, and adjust the 1983–86 weights to take account of the changes in employment outcomes that occurred over the period. Analogously to attributes, this reweighting gives more weight to 1983–86 households with employment outcomes that are more similar to the 1995–98 outcomes as predicted by their attributes, and less weight to households with outcomes less similar to 1995–98. The counterfactual distribution for all households, $\hat{f}_0^{EXNH}(y)$, is equal to the (w_{1j}) weighted average of the household type counterfactuals, $\hat{f}_{0j}^{EXN}(y)$, estimated using the employment and attribute "re-weights". The estimated marginal change in the distribution attributable to employment changes, $\Delta\hat{f}_0^{E}(y)$, is the difference between $\hat{f}_0^{EXNH}(y)$ and $\hat{f}_0^{XNH}(y)$.

Figure 4d shows the counterfactual distributions, $\hat{f}_0^{EXNH}(y)$ and $\hat{f}_0^{XNH}(y)$, while Figure 5d displays the marginal effect of changing employment outcomes on the income distribution, $\Delta\hat{f}_0^{E}(y)$, together with the total change in the equivalised income distribution over the period. Reflecting the predominant drop in employment over the sample period, these figures highlight the broad downward shift in mass from the top to the bottom half of the distribution. The density changes attributable to the changes in household employment account for 20% of the total density change.

3.6 Economic returns to attributes

The final factor we consider is that of changes in the "economic returns" to attributes over the period. For example, Dixon (1998) and Maani (1999) document increases in the earnings premia associated with qualifications between the mid 1980s and the mid 1990s. This likely increased the dispersion in individual incomes and, with

[20] Appendix Table A2 describes the employment-outcome grouping for each household type, together with the distributions of outcomes in the three periods 1983–86, 1989–92, and 1995–98. As indicated by Table 1, there was a broad shift from full-time employment to part-time and unemployed between 1983–86 and 1989–92, followed by a partial employment recovery by 1995–98.

positive assortive matching of couples,[21] would increase the dispersion in household incomes.

To adjust the distribution of income to take account of changes in the returns to attributes we begin by estimating specifications for log income in terms of the sets of socio-demographic attributes described above, separately for each household type and period.[22] Each 1983–86 household's equivalised income is adjusted using the predicted income change between 1983–86 and 1995–98 given its set of attributes using these estimated specifications. We then construct the counterfactual distribution, $\hat{f}_0^{REXNH}(y)$, equal to the weighted average of the household type counterfactuals which incorporate this changed income, $\hat{f}_{0j}^{REXN}(y)$. The marginal change in the distribution due to changes in the economic returns to attributes, $\Delta\hat{f}_0^{R}(y)$, is the difference between $\hat{f}_0^{REXNH}(y)$ and $\hat{f}_0^{EXNH}(y)$.

Figure 4e shows the counterfactual distributions, $\hat{f}_0^{REXNH}(y)$ and $\hat{f}_0^{EXNH}(y)$, while Figure 5e displays the marginal effect of changes in the returns on the income distribution $\Delta\hat{f}_0^{R}(y)$ together with the total change in the actual distribution over the period. These figures suggest there has been little systematic effect of changes in the returns to the socio-demographic characteristics of households over this period on the household income distribution, and the density changes attributable to changing returns account for only 2% of the total density change over the period.

3.7 Summary of explained changes

Figure 4f shows the final counterfactual density, $\hat{f}_0^{REXNH}(y)$, together with the actual 1983–86 distribution of household income; Figure 5f shows the total change explained by these factors (the difference between the final counterfactual and 1983–86 densities) together with the total change over the period (Equation 1b). These factors appear to provide a reasonable account of the downwards-shifting mass, but less of the

[21] For example, see Callister (2001).

[22] As our objective here is to translate the distribution, and in order to minimise the effect of possible outliers, we use Median (Quantile) regression techniques rather than least squares regression. We omit from the regression estimation any households with either left or right censored log equivalised income, however we adjust the *actual* (uncensored) incomes of these individuals before recensoring the adjusted log equivalised income at seven and 12.25. The 1983–86 log income measure we use is that which has already been adjusted for statutory changes in NS, as described above.

upwards-shifting mass, in the distribution. Collectively, this set of explanatory factors account for about 60% of the total density change.[23]

There are several possible reasons for the unexplained changes in the higher income ranges. First, these may be related to changes in the intensity of employment over the period—e.g, Dixon (1998) documents a large increase in the numbers of hours worked by workers over the late 1980s and early 1990s, and that the increase is positively correlated with wages. To the extent such changes are uncorrelated with the observable socio-demographic characteristics of households, this may contribute to the increase in the fraction of high-income households. The lack of any discernible distributional effects associated with changes in returns to attributes suggests that this may be true. Closely related to this last point is that there may have been changes in returns to unobservable characteristics that are orthogonal to the set of observable attributes. A third reason for the unexplained changes in the top half of the income distribution may be related to factors driving changes in unearned income—e.g. the introduction of a fringe benefit tax in 1985 led to a substitution away from in-kind remuneration towards cash remuneration, which would have increased incomes most for high income earners.

4 Implications for changes in income inequality between 1983–86 and 1995–98

In this section we use the counterfactual distributions of income discussed in the last section to estimate the contribution of each set of explanatory factors to various measures of equivalised income inequality over the period. Table 3 summarises the effects on the *levels* of inequality of these factors. First, in panel A we present the 10th, 25th, 50th (median), 75th, and 90th percentiles of the income distribution for the two actual and five counterfactual distributions. These percentiles provide a quantitative summary of the various distributions, and comparing adjacent columns of the table indicates the estimated marginal effects of the various factors on the distributions observed in Figure 4.

The results in columns one and two confirm that changing household structure tended to lower the bottom end and raise the top end of the income

[23] That is, the sum of the regression coefficients of the explained density changes on the total density change is 0.59 (see Table 2).

distribution: equivalised income fell by about 5% (from $17,365 to $16,573) at the 10th percentile and 6% at the 25th percentile, was roughly constant at the median, and increased by 1% at both the 75th and 90th percentiles. Despite the effect of changes in NS rates on the distribution, apparent in Figures 4b and 5b, the effect was localised and had very little impact on the percentiles here (see column three). The changes in household socio-demographic attributes (column four) tended to raise the distribution of income, particularly at higher incomes: equivalised income increased by between 1% at the 10th percentile, and 8% at the 75th percentile of the distribution. The estimated effects of changing employment outcomes (column five) are to lower incomes by 3–6% at each of the five percentiles, while the estimated change in returns to attributes (column six) raises equivalised income by between 2% and 6% at the various percentiles. Finally, comparing columns six and seven shows the unexplained changes: broadly speaking, the combined factors examined here appear to provide a reasonable account of the observed changes in the distribution at these percentiles.

In panel B of Table 3, for each of the distributions in panel A we show five summary measures of inequality commonly used in the literature. These are the Gini coefficient, the standard deviation of log income (SD), the interquartile range of log income (IQR), and the log differences between the 90th and 50th (90–50) and the 50th and 10th (50–10) percentiles of the distribution. Comparing adjacent columns provides a similar interpretation as for the percentiles in panel A.[24] Table 4 summarises the marginal effect of each factor on the change in these inequality measures over the period. As the decomposition of changes in inequality is carried out sequentially, the results are potentially sensitive to the sequence order. The first row in each panel contains the marginal relative change due to each of the factors in the order discussed in the last section. To gauge the robustness of the results to the sequence order, we have also repeated the analysis for all possible orderings, and summarise the range of effects for each measure in rows 2–5 of each block of Table 4.[25]

[24] Bootstrap standard errors for each of the statistics are shown in brackets. These are based on 100 replications where, for each replication, a full set of counterfactual estimates were generated and inequality measures calculated.

[25] Taking the mean of these different orderings is equivalent to a so-called Shapley decomposition (see Shorrocks, 1999).

Table 3: Implications for measures of income inequality

	Actual 1983-86 Distribution (1)	Counterfactual Distribution Allowing Changes in: Household Structure (2)	+National Superannuation (3)	+Household Attributes (4)	+Employment Outcomes (5)	+Economic Returns (6)	Actual 1995-98 Distribution (7)
		A: Percentiles of the equivalised income distribution					
10th	17,365	16,573	16,582	16,852	15,983	16,894	16,746
25th	24,352	23,696	23,545	24,334	22,897	23,307	22,316
50th	36,495	36,370	36,363	38,334	36,049	37,038	35,703
75th	53,599	54,228	54,241	58,374	54,886	57,154	57,366
90th	74,329	75,357	75,295	80,081	77,688	80,611	83,405
		B: Summary measures of equivalised income inequality					
Gini	0.316	0.324	0.324	0.334	0.341	0.340	0.367
	(.002)	(.002)	(.002)	(.003)	(.004)	(.005)	(.003)
SD	0.691	0.699	0.699	0.736	0.732	0.730	0.762
	(.010)	(.009)	(.009)	(.013)	(.015)	(.016)	(.010)
IQR	0.789	0.828	0.835	0.875	0.874	0.897	0.944
	(.009)	(.009)	(.010)	(.010)	(.018)	(.021)	(.012)
90–50	0.711	0.729	0.728	0.737	0.768	0.778	0.848
	(.009)	(.009)	(.009)	(.011)	(.017)	(.020)	(.014)
50–10	0.743	0.786	0.785	0.822	0.813	0.785	0.757
	(.008)	(.010)	(.010)	(.015)	(.020)	(.019)	(.012)

Notes: In panel A, the percentiles are in constant (1999) dollar values. In panel B, bootstrap standard errors are shown in parentheses. Gini is the Gini coefficient of income; SD is the standard deviation of log(income); IQR is the Interquartile range of log(income); 90–50 is the difference between the 90th and 50th percentiles of the log(income) distribution; and 50–10 is the difference between the 50th and 10th percentiles of the log(income) distribution.

Table 4: Contributions to change in inequality, 1983–86 to 1995–98

	Marginal relative change attributable to					
	Household types	**NS**	**Attributes**	**Employment**	**Returns**	**Explained**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
			Gini (Total Change = 15.9%; se = 1.3)			
Primary order	15.4	0.9	18.8	13.7	-1.4	47.4
	(1.6)	(0.2)	(4.0)	(4.9)	(9.3)	(9.3)
Mean	14.7	0.9	17.0	18.0	-5.7	44.8
Median	15.4	0.9	17.8	18.3	-6.2	46.9
Min	11.6	0.5	9.5	13.7	-12.6	37.3
Max	18.6	1.1	24.0	22.7	3.7	51.8
			SD (Total Change = 10.3%; se = 2.0)			
Primary order	11.5	0.1	51.7	-5.7	-2.0	55.6
	(3.6)	(0.4)	(16.6)	(12.7)	(11.5)	(22.1)
Mean	9.6	0.1	62.9	-3.7	-15.4	53.5
Median	9.9	0.1	62.8	-3.6	-16.4	56.1
Min	2.1	-0.4	48.3	-9.8	-30.1	36.4
Max	17.9	0.3	79.3	5.9	-0.1	73.2
			IQR (Total Change = 19.7%; se = 1.8)			
Primary order	25.1	4.3	26.1	-0.5	14.7	69.6
	(3.3)	(1.5)	(4.4)	(9.4)	(15.6)	(12.8)
Mean	25.5	4.5	23.2	11.1	-4.9	59.4
Median	25.6	4.2	24.6	8.6	-7.2	59.2
Min	15.1	-2.9	6.1	-2.8	-24.3	48.5
Max	32.8	12.7	33.5	36.1	15.0	70.6
			90–50 (Total Change = 19.3%; se = 2.4)			
Primary order	12.5	-0.5	6.5	22.7	7.2	48.4
	(2.9)	(0.7)	(6.9)	(11.0)	(18.0)	(15.1)
Mean	15.2	0.4	1.5	32.1	0.1	49.3
Median	14.2	0.3	5.7	32.2	3.9	48.2
Min	10.6	-3.2	-22.4	18.4	-17.0	41.0
Max	27.2	4.1	27.1	42.4	18.5	59.7
			50–10 (Total Change = 1.9%; se = 2.0)			
Primary order	301.5	-5.2	255.1	-59.3	-197.6	294.6
	(4884)	(199)	(5122)	(2385)	(10683)	(3728)
Mean	184.9	-18.4	376.8	-72.1	-337.8	133.3
Median	181.5	-15.9	391.1	-59.2	-294.6	78.4
Min	2.2	-101.2	137.5	-287.1	-586.8	-94.1
Max	441.2	20.5	589.0	150.8	-140.0	423.1

Notes: All table entries are expressed as percentages of the total change. The "Primary order" results are derived from Table 3, with bootstrap standard errors in parentheses. All other results are based on the 120 possible orderings of the five sets of factors. Gini is the Gini coefficient of income; SD is the standard deviation of log(income); IQR is the interquartile range of log(income); 90–50 is the difference between the 90th and 50th percentiles of the log(income) distribution; and 50–10 is the difference between the 50th and 10th percentiles of the log(income) distribution.

There are several points to note from Table 3, panel B and Table 4. First, the increase in (actual) inequality varies according to the measure of inequality, reflecting both that the increase in dispersion in incomes was not even across the distribution and that each measure weights changes differently. For example, the Gini coefficient gives similar weight to changes in income at different points in the distribution, whereas SD is more sensitive to changes in the tails of the distribution.[26] Likewise, the 90–50 and 50–10 measures capture only changes in the upper and lower half of the distribution respectively, while the IQR summarises changes in the "shoulders" of the distribution. Over the period the Gini coefficient increased by 16%, SD by 10%, IQR by 20%, the 90–50 difference 19%, and the 50–10 difference by 2%. Because the change in the 50–10 difference is small and statistically insignificant, the factor-specific contributions in Table 4 are sensitive to sampling variation: for this reason, we largely ignore changes in the 50–10 difference in the subsequent discussion.[27]

Second, the factor-specific contributions vary across the inequality measures, although changes in household structure and socio-demographic attributes tend to provide the largest marginal contributions to the change in inequality. For the primary ordering, household structure changes contribute about 15% of the increase in the Gini, 12% of the increases in SD and the 90–50 difference, 25% of the increase in the IQR, and 13% of the increase in the 90–50 difference over the period. Socio-demographic attribute changes explain between 7% of the increase in the 90–50 difference and about one-half of the increase in SD. Somewhat surprisingly, employment changes account for less of the change in inequality, except in the 90–50 difference, where this factor provides the single largest contribution (23%) to the increase in the top half of the distribution. Finally, the results in Table 4 support the earlier graphical finding that changes in the returns to household attributes had little systematic effect on income inequality over this period: the only statistically significant contribution of the returns was to the change in SD, and changing returns acted to reduce this measure of inequality.

[26] See Burniaux et al (1998) for a more general discussion.
[27] A more robust way to understand the causes of changes in the lower half of the distribution is to examine the relevant percentiles in panel A of Table 3.

Collectively, the factors considered account for around one-half of the increase in the Gini, SD and the 90–50 difference, and two-thirds of the increase in the IQR. These fractions are broadly similar to those for the density change estimated in the previous section, and represent significant contributions to the observed increase in inequality over the sample period.

Finally, although the order of decomposition does affect the estimated contribution of each factor, the general pattern of findings noted here does not change. For example, the mean and median values of the 120 orderings are generally close to estimates from the primary ordering–e.g. the mean and median lie within one standard error of the primary ordering estimate for 26 of the 30 marginal effects. The discrepancies tend to be slightly larger for the later factors in the primary ordering (employment and returns).

4.1 Robustness to alternative equivalisation, income and weight measures

Thus far, the analysis of income inequality changes has been in terms of changes in equivalised gross household income, weighted to represent individuals. The choices of equivalisation, income and weight may each have non-trivial implications for the results. For this reason, we now examine the robustness of the results across a range of alternative measures, which emphasise different aspects of distributional change. We restrict our attention to five alternatives, across three equivalence scales—the Luxembourg (0.5) equivalence scale used above, the per capita equivalisation, and unequivalised for household composition; three income measures—gross, estimated post-tax, and estimated *disposable* (i.e. post-tax and rebates);[28] and three weights—person weights, *equivalised* person weights, and household weights.[29] In particular, we examine per capita gross income weighted

[28] We estimate household post-tax income as the sum of individuals' post-tax income, which is calculated using the income tax scale during the tax year in which they were surveyed and applied to their reported gross income. We estimate household disposable income using the "household cash disposable income" measure estimated from the NZ Treasury's TAXMOD model for income tax and rebates for the 1995–98 period. TAXMOD is only operational for the 1987/88 and subsequent tax years. For this reason, for the 1983–86 period we estimate household disposable income using the income tax scale applied to individual incomes just described, together with an estimate of the major income and family tax rebates, applied on the assumption that the household can be treated as a family for tax purposes.

[29] Equivalised household income weighted to represent equivalised persons, per capita income weighted to represent persons, and household income weighted to represent households each has the property that they aggregate to total household income.

to represent individuals, equivalised gross income weighted to represent equivalised persons, equivalised post-tax income weighted to represent individuals, equivalised disposable income weighted to represent individuals, and unequivalised gross household income weighted to represent households.[30]

Table 5 summarises the implications for changes in inequality based on these five alternatives together with the Luxembourg equivalised gross household income weighted to represent individuals. Table 5 includes five panels (A–E) which correspond to the five alternative measures of inequality that we considered earlier. The first row in each panel presents the relative change in inequality between 1983–86 and 1995–98, using each of the alternative income measures. Subsequent rows contain the relative contributions to the change in inequality from each set of factors, using each of the alternative income measures.

The measured increase in inequality tends to be larger using the post-tax and disposable income measures, and lower using the per capita income measure. This is consistent with the reduction in the top marginal tax rate from 60% to 33% during the period. Also, although the factor contributions are reasonably comparable across the income measures, the contributions using post-tax and disposable incomes are generally lower than for other income measures, possibly because the tax rate changes were largely unrelated to the factors considered in our counterfactuals. For example, the explained fractions of the increase in inequality as measured by the Gini coefficient are only one-quarter using equivalised post-tax income, and less than one-fifth using equivalised disposable income, versus 40–60% using the gross income measures. Overall, given the range of concepts considered, we believe the results are remarkably similar across these alternative measures.

[30] A detailed analysis of unequivalised gross household income weighted to represent households is presented in Hyslop and Maré (2001).

Table 5: Robustness to alternative income and weight measures

Equivalisation: Income: Weight:	Equivalised Gross Person (1)	Per capita Gross Person (2)	Equivalised Gross Equiv-person (3)	Equivalised Post-tax Person (4)	Equivalised Disposable Person (5)	Unequivalised Gross Household (6)
			A: Gini coefficient			
Relative change	15.9	13.0	15.7	20.9	18.8	14.8
Contributions by:						
Household types	15.4	12.2	14.4	12.6	11.4	17.7
NS	0.9	3.0	0.6	0.7	0.8	0.7
Attributes	18.8	15.7	19.6	10.9	15.1	17.1
Employment	13.7	21.7	15.3	7.8	5.1	8.4
Returns	-1.4	-6.1	-9.6	-5.5	-15.2	-2.0
Explained	47.4	53.5	59.7	26.5	17.1	40.5
			B: Standard deviation of log(income)			
Relative change	10.3	9.7	9.9	11.8	12.8	8.9
Contributions by:						
Household types	11.5	16.9	11.1	10.8	5.4	14.3
NS	0.1	1.4	-0.6	-0.1	0.0	-6.5
Attributes	51.7	38.1	52.3	40.0	39.5	47.2
Employment	-5.7	5.7	1.4	-7.6	-9.9	2.0
Returns	-2.0	-14.2	-18.8	-15.4	-22.6	-4.6
Explained	55.6	52.2	54.7	27.7	12.4	52.3
			C: Interquartile range			
Relative change	19.7	14.2	18.4	21.7	15.5	14.9
Contributions by:						
Household types	25.1	32.4	24.9	29.0	32.0	32.8
NS	4.3	5.5	6.4	5.5	5.4	6.8
Attributes	26.1	24.0	28.0	14.0	26.8	34.1
Employment	–0.5	6.8	7.0	-0.4	-14.1	3.5
Returns	14.7	-6.0	-10.3	0.9	-16.6	-19.4
Explained	69.6	37.2	43.9	49.1	33.6	57.8
			D: 90–50 difference			
Relative change	19.3	12.2	20.2	21.6	18.6	26.3
Contributions by:						
Household types	12.5	18.2	8.9	13.2	14.5	15.3
NS	-0.5	-1.3	-0.2	0.5	2.2	0.6
Attributes	6.5	27.7	10.3	10.2	12.4	9.1
Employment	22.7	42.4	22.9	13.1	12.6	15.5
Returns	7.2	-14.4	18.4	16.0	-1.3	2.8
Explained	48.4	27.4	39.7	52.9	40.4	43.3
			E: 50–10 difference			
Relative change	1.9	4.2	0.5	3.1	2.1	-3.7

Notes*: The first row entries in each panel are the percentage increases in inequality between 1983–86 and 1995–98; the entries in the subsequent rows are the percentage contribution by each set of factors. As the 50–10 relative changes are all small, we do not report the factor contributions.*

4.2 Changes in the household type distributions of equivalised income

We now summarise the results of the analysis for changes in the sub-distributions of income for each of the six household types described above. This analysis provides a sense of how changes in the overall distribution of household income are attributable to changes in the distribution within the various household types. The discussion in this section focuses on the summary measures of inequality, as summarised in Table 6. The first column contains the actual change in each measure of inequality over the period together with the relative change in parentheses, while subsequent columns contain the relative marginal contribution of each factor. These results provide further evidence on the complexity of the changing distribution of household incomes over this period.

First, there were quite diverse changes in income inequality across the various household types. With the exception of the "single adult with children" households, there were strong increases in income inequality for the working-age households. For example, the Gini coefficient increased by about 20% for each of these three groups. In contrast, the level of inequality among "single adult with children" households actually fell: by 19% for the Gini, and between 5 and 25% using other measures.

Table 6: Changes in income inequality 1983–86 to 1995–98, by household types

	Total change in inequality (1)	Relative marginal effect of changes in NS (2)	Household attributes (3)	Employment outcomes (4)	Economic returns (5)	Explained change (6)
		A: Single adult over 60				
Gini	0.003 (0.9)	-288.7	---	---	---	-288.7
SD	-0.007 (-1.5)	212.4	---	---	---	212.4
IQR	-0.055 (-11.0)	13.3	---	---	---	13.3
90–50	-0.067 (-7.8)	20.3	---	---	---	20.3
50–10	-0.016 (-9.9)	128.5	---	---	---	128.5
		B: Multiple adults over 60				
Gini	0.028 (9.4)	29.6	---	---	---	29.6
SD	0.072 (14.6)	19.1	---	---	---	19.1
IQR	-0.068 (-9.4)	-32.5	---	---	---	-32.5
90–50	0.090 (10.9)	41.7	---	---	---	41.7
50–10	-0.027 (-7.7)	-26.6	---	---	---	-26.6
		C: Single adult under 60				
Gini	0.053 (16.3)	0.0	6.4	52.6	21.7	80.7
SD	0.013 (1.6)	-0.2	199.5	552.0	59.2	810.5
IQR	0.276 (37.0)	0.0	21.5	43.9	33.5	98.8
90–50	0.182 (28.2)	0.0	-22.4	28.2	25.0	30.8
50–10	-0.030 (-2.8)	0.0	-302.9	111.1	30.9	-160.9
		D: Multiple adults under 60				
Gini	0.062 (25.1)	0.0	4.1	32.4	-1.0	35.5
SD	0.149 (26.1)	-0.1	29.4	28.0	0.4	57.7
IQR	0.113 (19.3)	2.0	-7.3	63.5	-17.8	40.5
90–50	0.141 (30.1)	0.0	-0.7	24.2	17.6	41.1
50–10	0.236 (37.3)	-0.8	15.8	41.5	-19.2	37.2
		E: Single adult with children				
Gini	-0.057 (-18.9)	0.1	-27.8	55.3	26.6	54.2
SD	-0.031 (-5.5)	-0.5	-145.5	132.8	109.6	96.4
IQR	-0.101 (-23.1)	3.3	-73.9	86.3	73.9	89.6
90–50	-0.162 (-24.5)	0.0	-72.7	126.0	27.9	81.2
50–10	-0.087 (-19.9)	0.0	-14.7	17.2	-85.8	-83.2
		F: Multiple adults with children				
Gini	0.063 (21.9)	0.0	14.1	14.1	32.9	61.1
SD	0.080 (11.7)	0.0	39.1	-21.9	43.8	61.0
IQR	0.170 (26.7)	-0.6	14.7	10.5	23.2	47.8
90–50	0.148 (24.7)	-0.3	16.8	22.3	30.5	69.3
50–10	0.068 (9.8)	1.0	32.6	-7.8	87.7	113.6

Notes: The numbers in column (1) are raw changes (with percentage changes in parentheses). The numbers in columns (2)–(6) are percentages of the total change.

Second, although changing employment outcomes had a comparatively modest effect on changing inequality at the aggregate level, this factor had the strongest effect on inequality changes within each household type. For example, employment changes account for 53%, 32% and 14% of the increase in the Gini for single-adult, multiple-adult, and multiple adult with children households respectively, and 55% of the decrease among single adult with children households. The difference in the importance of employment changes in the household type and aggregate analyses is because employment changes for high-income households (multiple adults with children and multiple adults under the age of 60, which account for more than one-half and 20–25% of households respectively) lead to a "spreading down" of the distribution, compressing the overall distribution and counterbalancing the increase in inequality from within household types. In contrast, the changes in returns also contributed significantly to the changes in inequality within the single-adult household groups.

Third, the changes for the "retired" household types are less consistent across measures. For example, the Gini coefficient and standard deviation of log income measures of inequality were static for singles and increased 9 and 15% respectively for multiple adult households, while the IQR and 50–10 difference measures decreased (by 8 to 11%), and the 90–50 difference increased 11% for multiple-adult households but decreased 8% for singles. As expected, NS changes contribute significantly to these changes. However, there are apparently other factors at work, particularly in the case of the multiple-adult households. For example, although the IQR and 50–10 difference fell, the effects of NS changes acted to increase these measures. Although we haven't examined other factors for these groups, given the increasing age of eligibility, employment effects plausibly contribute to the changes for this group.

4.3 Sub-period changes in the distribution of household incomes

As we observed in Section 2, most of the changes appear to have occurred during the late 1980s. In particular, the dramatic increase in Gini coefficients, the shift in the distribution of household types, and the drop in employment were concentrated in this period. To examine the effects of changes in the sets of factors over the 1980s and 1990s, we repeat the analysis described in

Section 3, applied to the two sub-periods from 1983–86 to 1989–92, and from 1989–92 to 1995–98. For each sub-period, we decompose changes relative to the initial period.

Figure 6 presents the household equivalised income distributions across these two sub-periods, and the total and explained changes.[31] Comparing Figures 6a and 6b, and Figures 6c and 6d, confirms that most of the change in the income distribution occurred during the 1980s. The hollowing out of the middle-income range, and the redistribution to the low and high ends of the distribution, occurred mainly between 1983–86 and 1989–92. Figure 6c suggests that the various sets of factors again provide a reasonable account of the downward shifts from the middle to the low end of the income distribution, while the upward shift is again less well explained. Between 1989–92 and 1995–98, the main change appears to be a downwards shift in mass around the middle of the distribution, although there is also a discernible increase in density at the top end of the distribution. Figure 6d shows that these changes are partially explained by the factors we focus on.

[31] The full set of figures corresponding to the various counterfactuals is included in Hyslop and Maré (2001).

Figure 6: Distribution of household gross incomes

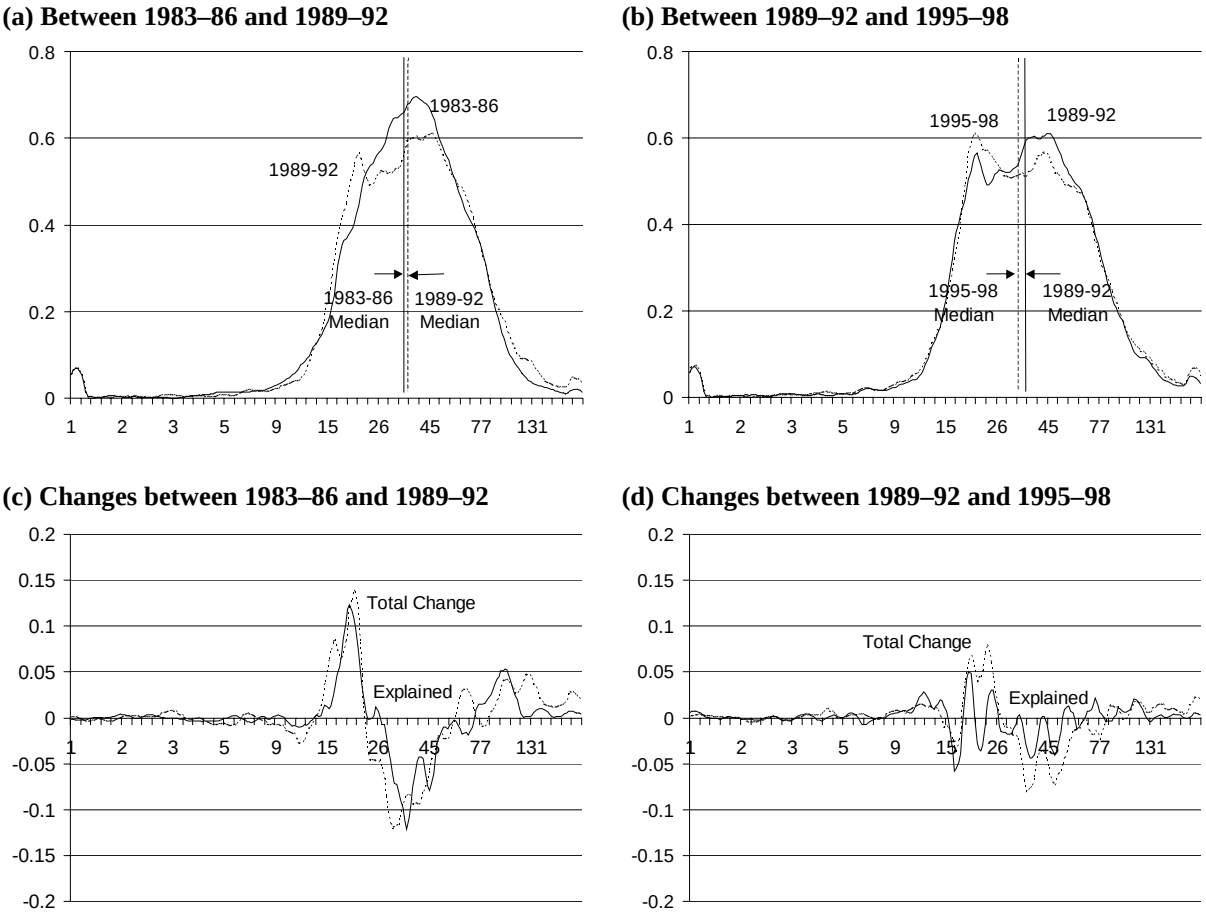


Table 7 summarises the decomposition in the alternative measures of inequality attributable to the various sets of factors over the two sub-periods. Depending on the inequality measure used, between about one-half and 70% of the increase in inequality occurred during the first sub-period from 1983–86 to 1989–92. The results for this period tell a consistent story to that for the full period shown in Table 4 and Table 5. Changes in household structure and attributes again provide significant contributions to the change in inequality, although employment changes also play a large part over this period. The greater contribution of employment changes to changes in inequality is because the employment loss in the 1980s served to increase inequality, whereas the employment gain in the 1990s acted to reduce inequality. This is apparent in panel B, where employment changes tended to contribute *negatively* over the 1989–92 to 1995–98 period. The full-period analysis above does not separate these effects.

The predicted effect of changes in the return to attributes is to reduce inequality in each sub-period, and thus contributes negatively to the observed increases. The results also indicate that the sets of factors considered tend to account for a larger fraction of the increase in inequality over the 1980s than the 1990s.

Table 7: Sub-period changes in income inequality

	Actual change	Relative change in inequality attributable to					
		Household types	NS	Attributes	Employment	Returns	Explained change
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				A: 1983–86 to 1989–92			
Gini	0.031	17.7	1.5	13.5	30.5	-12.9	50.2
[60.9]	(9.7)						
SD	0.039	6.2	1.2	54.3	2.9	-19.6	45.1
[54.0]	(5.6)						
IQR	0.112	23.3	3.3	16.8	18.1	-11.1	50.4
[72.4]	(14.2)						
90–50	0.063	25.2	-1.4	-2.8	64.2	-2.8	82.3
[46.1]	(8.9)						
50–10	0.023	79.8	1.5	84.8	12.1	-236.5	-58.2
[158.1]	(3.1)						
				B: 1989–92 to 1995–98			
Gini	0.020	9.8	-0.1	33.1	-6.3	-4.3	32.2
	(5.7)						
SD	0.033	15.4	-1.1	57.0	-3.2	-17.4	50.6
	(4.5)						
IQR	0.043	39.2	6.6	32.9	-20.5	-23.7	31.5
	(4.8)						
90–50	0.074	11.6	2.6	11.8	2.4	-6.3	22.1
	(9.5)						
50–10	-0.008	-157.8	29.2	-380.7	135.9	202.8	-170.7
	(-1.1)						

Notes: The numbers in square brackets in panel A are the fractions of the change in inequality over the full period (1983–86 to 1995–98) that occurred in the first sub-period (1983–86 to 1989–92). Column (1) presents the actual change in inequality over each sub-period (together with the percentage change in parentheses). Columns (2)–(7) present the marginal change explained by each counterfactual as a percentage of the total change.

5 Concluding discussion

The semiparametric analysis of changes in the distribution of equivalised household income in New Zealand between 1983 and 1998 presented above provides both a visual appreciation of the levels and changes in the distribution, and a more informative analysis than that based on summary measures of inequality alone or on changes in mean incomes. As has been documented in other research, we find that the sizeable increase in inequality was concentrated during the late 1980s. However, our analysis shows that the changes in the distribution of income involved a complex set of factors which are difficult to summarise using a single measure of inequality. We find that the main factors contributing to the change in inequality were changes in household structure and changes in the socio-demographic attributes of households, which each explain one-sixth of the total increase in the Gini coefficient over the period, and up to one-quarter and one-half respectively of other measures of inequality. In contrast, we find that the large changes in the employment outcomes of households had a more modest impact on overall income inequality, although these changes do have a large effect on the observed change in inequality within household types. We also find little evidence of any systematic effects of changes in the economic returns to socio-demographic attributes on the income distribution or inequality over the period. These results are qualitatively robust to a variety of alternative equivalisation, income, and weighting measures.

The study was motivated by the coincidence of increasing inequality in New Zealand and widespread economic and social policy reform during the late 1980s and early 1990s. Although it is not possible to attribute distributional changes to particular policy measures, our analysis and findings do provide some guidance for understanding the nature of the impact of the reforms, and the relative importance of different sets of reforms. First, the fact that the main increase in inequality occurred during the late 1980s rules out the 1991 Employment Contracts Act and benefit reforms as primary causes of change, as has been claimed by some commentators. The most significant reforms during this period were the removal of subsidies to industry, trade protection, and the reform of the public sector. The most likely way in which these reforms affected inequality is through employment effects associated with job loss in affected

industries. Overall, our results suggest that this factor may have contributed up to 20% of the observed increase in inequality over the full period, although a larger fraction over the late 1980s. Second, the significant roles played by changes in household structure and the socio-demographic attributes of households suggest that secular changes in, for example, population ageing, family structure preferences, and education and qualification levels, were major drivers of the increase in inequality; although arguably some of these changes may have been in response to the changing environment brought about by the reforms.

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Appendix A: Construction of counterfactual distributions

In this appendix we provide details of the counterfactual distributions constructed to analyse changes in the distribution of household equivalised income between period 0 and period 1. The description of the analysis is analogous to that presented in DiNardo et al (1996), while Silverman (1986) provides a detailed account of kernel density estimation. This involves a combination of conditionally translating and reweighting empirical distributions to take account of changes in the various sets of factors of interest.

Household types

The estimated density of log household equivalised income in period t, $\hat{f}_t(y)$, can be expressed as the weighted average density across the J distinct household types, $\hat{f}_t(y) = \sum_{j=1}^{J} w_{tj} \cdot \hat{f}_{tj}(y)$, where w_{tj} is the fraction of individuals living in household type j in period t ($w_{tj} = \sum_{i=1}^{N_{tj}} \theta_{ti}$, where θ_{ti} is the sampling weight for household I multiplied by the number of persons in the household in period t, and N_{tj} is the number of type j households in period t), and $\hat{f}_{tj}(y)$ is the estimated density for household type j in period t. The counterfactual distribution of income which allows the distribution of households to change from period 0 to period 1, but holds the distribution of household type incomes constant as in period 0, is simply

$$\hat{f}_0^H(y) = \sum_{j=1}^{J} w_{1j} \cdot \hat{f}_{0j}(y) \qquad \text{(A1a)}$$

That is, $\hat{f}_0^H(y)$ is obtained by reweighting the period 0 household type income densities by the period 1 household type fractions. The estimated change in the distribution explained by this counterfactual is

$$\Delta\hat{f}^H(y) = \hat{f}_0^H(y) - \hat{f}_0(y) = \sum_{j=1}^{J} \left(w_{1j} - w_{0j}\right)\hat{f}_{0j}(y) \qquad \text{(A1b)}$$

National Superannuation

The effects of changes in the statutory rate(s) of NS over the period can be expressed in terms of translations of incomes as follows. Let Y_{ti} be the level of income of household i in year t (i.e. $y_{ti} = \log(Y_{ti})$), and let Y_{ti}^N be the NS component of income for the household. Constructing a counterfactual distribution for changes in NS rates requires adjusting the actual NS received in period 0 (Y_{0i}^N) to take account of the statutory changes between period 0 and period 1. We denote this change $\pi_i = NS_{1i}/NS_{0i}$, where NS_{0i} and NS_{1i} are the statutory rates of NS applicable to household *i* in period 0 and exactly 12 years later.[32] The adjusted (log) total income for the household in period 0 is then obtained by scaling the actual NS received in period 0 to account for the statutory-rate change, $\hat{y}_{0i}^N = \log\left(Y_{0i} + (\pi_i - 1)Y_{0i}^N\right)$. For each household type j, we then obtain kernel density estimates of the distribution of $\hat{y}_{0i}^N$, $\hat{f}_{0j}^N(y) = \sum_{i=1}^{N_j} \frac{\theta_{0i}}{h} . K\left(\frac{y - \hat{y}_{0i}^N}{h}\right)$.

Conditional on changes in the distribution of household types, the counterfactual distribution of income across all households is

$$\hat{f}_0^{NH}(y) = \sum_{j=1}^{J} w_{1j} . \hat{f}_{0j}^N(y) \qquad \text{(A2a)}$$

and the marginal effect of the change in the distribution explained by changes in NS rates is

$$\Delta\hat{f}^N(y) = \hat{f}_0^{NH}(y) - \hat{f}_0^H(y) = \sum_{j=1}^{J} w_{1j} . (\hat{f}_{0j}^N(y) - \hat{f}_{0j}(y)) \qquad \text{(A2b)}$$

Household socio-demographic attributes

The effects of changes in the socio-demographic attributes and employment outcomes of households on the distribution of household income can be captured by reweighting the period 0 sample weights to take account of changes in such attributes and employment outcomes between period 0 and period 1. To facilitate this, we express the household type density of income as the

[32] For households with one person aged over 60 we apply the statutory rate for single people, while for households with at least two people aged over 60 we apply the statutory rate for couples. If the household has no one aged over 60, we set $\pi_{ji} = 0$. NS_{1i} is six years later than NS_{0i} for the 1983/86–1989/92 and 1989/92–1995/98 sub-period analyses.

integral of the density of income conditional on a set of household demographic attributes, x, and employment outcomes, e:

$$f_{tj}(y) = \int_{(e,x)\in\Omega_{(e,x)}} f_{tj}(y;x,e)dF_{tj}(e,x) \qquad \text{(A3)}$$

where $\Omega_{(e,x)}$ is the domain of the household employment outcomes and demographic attributes, and $F_{tj}(e, x)$ is the joint distribution of (e, x) for household type j in period t. In order to distinguish the effects of changes in the attributes and employment outcomes, we first analyse the effects of changes in demographics attributes, and then changes in employment outcomes conditional on attributes. This approach is captured by rewriting (A3) as

$$f_{tj}(y) = \int_{x\in\Omega_x} \int_{e\in\Omega_{e|x}} f_{tj}(y;x,e).dF_{tj}(e\,|\,x)\,dF_{tj}(x) \qquad \text{(A3′)}$$

For each household type j, we construct a counterfactual density allowing the distribution of attributes to be as observed in period 1, but holding the conditional distribution of employment outcomes and the density of incomes within each household type as in period 0:

$$\begin{aligned} f_{0j}^{XN}(y) &= \int_{x\in\Omega_x} \int_{e\in\Omega_{e|x}} f_{0j}^{N}(y;x,e).dF_{0j}(e\,|\,x)\,dF_{1j}(x) \\ &= \int_{x\in\Omega_x} \int_{e\in\Omega_{e|x}} f_{0j}^{N}(y;x,e).dF_{0j}(e\,|\,x).\psi_{xj}(x)\,dF_{0j}(x) \end{aligned} \qquad \text{(A4)}$$

where $\psi_{xj}(x) = dF_{1j}(x)/dF_{0j}(x)$ is a "reweighting" function which rescales the period 0 density of attributes to obtain the prevailing period 1 density. Note that, by applying Bayes' rule, this function can be expressed as

$$\psi_{xj}(x) = \frac{P_j(t=1,x)}{P_j(t=0,x)} = \frac{P_j(t=1\,|\,x)}{P_j(t=0\,|\,x)}.\frac{P_j(t=0)}{P_j(t=1)}$$

where (e.g.) $P_j(t = 1|x)$ is the conditional probability that a household with attributes x is observed in period 1, and $P_j(t = 1)$ is the unconditional probability that the household is observed in period 1.

In order to obtain estimates of the reweighting function, we first pool the period 0 and period 1 households and estimate the probability that household i is observed in period 1, given attributes x, for each household type j, using a logit

model for the binary dependent variable t.[33] We then use the estimates from this model to predict, for each household observed in period 0, the relative probability that it would be observed in period 1 versus period 0 (i.e. $\hat{P}_j(t=1 \mid x_{0i}) / \hat{P}_j(t=0 \mid x_{0i})$) and adjust this by $P_j(t = 0)/P_j(t = 1)$ to obtain the estimated "reweight" for this household, $\hat{\psi}_{xj}(x_{0i})$. The counterfactual density for household type j that takes account of changes in attributes is then estimated by

$$\hat{f}_{0j}^{XN}(y) = \sum_{i=1}^{N_j} \frac{\hat{\psi}_{xj}(x_{0i}).\theta_{0i}}{h} . K\left(\frac{y - \hat{y}_{0i}^{N}}{h}\right)$$

The counterfactual distribution of income across all households is estimated by

$$\hat{f}_0^{XNH}(y) = \sum_{j=1}^{J} w_{1j} . \hat{f}_{0j}^{XN}(y) \qquad \text{(A5a)}$$

and the estimated marginal effect of the change in the distribution that is explained by changes in socio-demographic attributes is

$$\Delta\hat{f}^{X}(y) = \hat{f}_0^{XNH}(y) - \hat{f}_0^{NH}(y) = \sum_{j=1}^{J} w_{1j} . (\hat{f}_{0j}^{XN}(y) - \hat{f}_{0j}^{N}(y)) \qquad \text{(A5b)}$$

Household employment outcomes

Returning to the effects of changes in employment outcomes conditional on changes in attributes, for each household type we construct a counterfactual density that allows the distribution of employment outcomes to be as in period 1, but the density of incomes conditional on employment to be as in period 0. That is

$$\begin{aligned} f_{0j}^{EXN}(y) &= \int_{x \in \Omega_x} \int_{e \in \Omega_{e|x}} f_{0j}^{N}(y;x,e) . dF_{1j}(e \mid x)\, dF_{1j}(x) \\ &= \int_{x \in \Omega_x} \int_{e \in \Omega_{e|x}} f_{0j}^{N}(y;x,e) . \psi_{e|x,j}(e,x) dF_{0j}(e \mid x) . \psi_{xj}(x)\, dF_{0j}(x) \end{aligned} \qquad \text{(A6)}$$

where $\psi_{e|x,j}(e,x) = dF_{1j}(e|x)/dF_{0j}(e|x)$ is a "reweighting" function which rescales the period 0 density of employment outcomes conditional on attributes to obtain the prevailing period 1 density. For this purpose, we consider a discrete set of M_j employment outcomes for household type j, defined according to the numbers of full-time workers and the presence of part-time workers in the household, and

[33] The logit specifications and model results are presented in column (1) of Appendix Tables A1(a)–A1(d) for each household type.

define $e_m = 1$ if the household has employment outcome m and $e_m = 0$ otherwise ($m = 0, \ldots, M_j$).[34] The reweighting function is

$$\psi_{e|x,j}(e,x) = \sum_{m=0}^{M_j} e_m \cdot \frac{P_{1j}(e_m = 1 \mid x)}{P_{0j}(e_m = 1 \mid x)}$$

where $P_{tj}(e_m = 1 \mid x)$ is the probability of employment outcome m in period t, given attributes x.

To estimate the reweighting function $\hat{\psi}_{e|x,j}(e_{0i}, x_{0i})$, we first estimate, separately for each period, ordered logit models for the employment outcome conditional on household *i* attributes $\hat{P}_{tj}(e_m = 1 \mid x_{ti})$. For each household observed in period 0, we then use these models to predict the relative probability of employment outcome e_m in period 1 versus period 0 and calculate

$$\hat{\psi}_{e|x,j}(e_{0i}, x_{0i}) = \sum_{m=0}^{M_j} e_{m0i} \cdot \frac{\hat{P}_{1j}(e_m = 1 \mid x_{0i})}{\hat{P}_{0j}(e_m = 1 \mid x_{0i})}$$

Given this estimated reweight, the counterfactual density for household type j that takes account of changes in employment outcomes is estimated by

$$\hat{f}_{0j}^{EXN}(y) = \sum_{i=1}^{N_{0j}} \frac{\hat{\psi}_{e|x,j}(e_{0i}, x_{0i}).\hat{\psi}_{xj}(x_{0i}).\theta_{0i}}{h} \cdot K\left(\frac{y - \hat{y}_{0i}^{N}}{h}\right)$$

The counterfactual distribution of income across all households is again obtained by taking the weighted average across household types:

$$\hat{f}_0^{EXNH}(y) = \sum_{j=1}^{J} w_{1j} \cdot \hat{f}_{0j}^{EXN}(y) \qquad \text{(A7a)}$$

and the marginal effect of changes in employment outcomes is

$$\Delta\hat{f}^{E}(y) = \hat{f}_0^{EXNH}(y) - \hat{f}_0^{XNH}(y) = \sum_{j=1}^{J} w_{1j} \cdot (\hat{f}_{0j}^{EXN}(y) - \hat{f}_{0j}^{XN}(y)) \qquad \text{(A7b)}$$

Economic returns to attributes

The final explanatory factor that we analyse is changes in the economic "returns" to attributes. For this exercise, we construct a counterfactual density allowing the income returns to observed household socio-demographic attributes

[34] The employment outcomes are described in Table 3 for each household type. Summaries of the model results are presented in columns (2) and (3) of Appendix Tables A1(a)–A1(d) for each household type.

to be as in period 1, by adjusting each household's period 0 income by the predicted change given their attributes.

In particular, for each household type j, we first estimate regressions of log equivalised income on socio-demographic attributes separately for each period

$$\hat{y}^{N}_{tji} = X_{tji}{}' \beta_{tj} + \varepsilon_{tji}$$ [35]

We compute the predicted change in returns, $\Delta\hat{y}_{ji} = X_{0ji}{}' (\hat{\beta}_{1j} - \hat{\beta}_{0j})$, and log household equivalised income adjusted for this change, $\hat{y}^{R}_{0ji} = \hat{y}^{N}_{0ji} + \Delta\hat{y}_{ji}$, and then obtain the counterfactual density for household type j that takes account of this change in returns

$$\hat{f}^{REXN}_{oj}(y) = \sum_{i=1}^{N_j} \frac{\hat{\psi}_{e|x,j}(e, x_{0i}).\hat{\psi}_{xj}(x_{0i}).\theta_{0i}}{h} . K\left(\frac{y - \hat{y}^{R}_{0i}}{h}\right)$$

The counterfactual distribution of income across all households is again obtained by taking the weighted average across household types:

$$\hat{f}^{REXNH}_{0}(y) = \sum_{j=1}^{J} w_{1j} . \hat{f}^{REXN}_{0j}(y) \qquad \text{(A8a)}$$

and the marginal effect of the change in the distribution explained by changes in economic returns is

$$\Delta\hat{f}^{R}(y) = \hat{f}^{REXNH}_{0}(y) - \hat{f}^{EXNH}_{0}(y) = \sum_{j=1}^{J} w_{1j} . (\hat{f}^{REXN}_{0j}(y) - \hat{f}^{EXN}_{0j}(y)) \qquad \text{(A8b)}$$

On the basis of these sequentially constructed counterfactual densities, the total change in the density of log household equivalised income between period 0 and period 1 can be decomposed into "explained" and "unexplained" components, as follows:

$$\hat{f}_{1}(y) - \hat{f}_{0}(y) = (\hat{f}^{REXNH}_{0}(y) - \hat{f}_{0}(y)) + \left(\hat{f}_{1}(y) - \hat{f}^{REXNH}_{0}(y)\right) \qquad \text{(A9)}$$

[35] We estimate these models using quantile (median) regression rather than least squares methods in order to minimise the effects of outliers on the estimated shifts in the returns. The results of these models are presented in columns (4) and (5) of Appendix Tables A1(a)–A1(d) for each household type.

where $\hat{f}_0^{REXNH}(y) - \hat{f}_0(y)$ represents the total change in the distribution explained by the sets of factors we have examined here, and $\hat{f}_1(y) - \hat{f}_0^{REXNH}(y)$ represents the change in the overall income distribution which remains unexplained.

Table A1(a): Counterfactual analysis for single adult under 60 households

Variable	Attributes	Employment outcomes		Economic returns	
		1983–86	1995–98	1983–86	1995–98
	(1)	(2)	(3)	(4)	(5)
Female	-0.040	-1.062	-0.675	-0.304	-0.213
	(.109)	(.193)	(.169)	(.055)	(.058)
Māori	0.925	-0.394	-0.784	-0.352	-0.282
	(.234)	(.311)	(.267)	(.137)	(.107)
Aged 15–18	1.119	-2.107	0.826	-0.034	0.090
	(.723)	(1.11)	(1.18)	(.273)	(.380)
Aged 25–39	0.905	-0.833	0.297	0.268	0.502
	(.210)	(.707)	(.396)	(.089)	(.126)
Aged 40–49	1.465	-1.251	0.205	0.272	0.637
	(.222)	(.703)	(.400)	(.099)	(.130)
Aged 50+	1.231	-2.257	-0.236	0.150	0.502
	(.215)	(.693)	(.389)	(.092)	(.129)
Highest qualification					
School	0.691	0.263	0.985	0.330	0.446
	(.146)	(.236)	(.217)	(.073)	(.078)
Vocational	0.376	0.620	0.894	0.411	0.439
	(.142)	(.239)	(.213)	(.069)	(.087)
University	0.908	1.634	1.571	0.665	0.855
	(.170)	(.379)	(.278)	(.086)	(.087)
Intercept	-1.210	---	---	10.248	9.836
	(.223)			(.095)	(.133)
First break	---	-3.292	-1.067	---	---
		(.710)	(.404)		
Second break	---	-3.011	-0.530	---	---
		(.708)	(.402)		
Pseudo R^2	0.043	0.139	0.081	0.131	0.131
Number of observations	1,608	814	794	796	779

Notes: Standard errors are in parentheses. All models are estimated using sampling weights. In column (1), the dependent variable equals 1 if the observation is from 1995–98, and 0 if from 1983–86, and the specification estimated is a Logit model. In columns (2) and (3), the dependent variable is defined in Table 3, and the specifications are Ordered Logit models. In columns (4) and (5), the dependent variable is log(household income), and the specifications are estimated using median regressions. See text for further details.

Table A1(b): Counterfactual analysis for multiple adults under 60 households

Variable	Attributes	Employment outcomes		Economic returns	
		1983–86	1995–98	1983–86	1995–98
	(1)	(2)	(3)	(4)	(5)
Number of adults	0.198	0.639	0.483	0.124	0.117
	(.047)	(.073)	(.058)	(.008)	(.023)
Fraction of adults:					
Female	0.156	-0.627	-0.578	-0.459	-0.092
	(.178)	(.262)	(.219)	(.031)	(.086)
Māori	1.614	0.049	-0.357	-0.037	-0.098
	(.179)	(.193)	(.198)	(.030)	(.075)
Married	0.209	0.766	0.953	0.147	0.190
	(.089)	(.130)	(.131)	(.013)	(.045)
Aged 15–18	-0.623	1.177	-0.212	0.117	-0.198
	(.287)	(.467)	(.348)	(.044)	(.144)
Aged 25–39	0.864	0.488	0.971	0.701	0.411
	(.128)	(.216)	(.192)	(.021)	(.066)
Aged 40–49	1.920	-0.060	0.496	0.763	0.486
	(.154)	(.228)	(.213)	(.023)	(.076)
Aged 50+	1.416	-1.887	-0.525	0.556	0.272
	(.136)	(.205)	(.193)	(.021)	(.070)
Fraction of adults with highest qualifications					
School	1.656	0.510	0.984	0.324	0.426
	(.123)	(.155)	(.158)	(.017)	(.061)
Vocational	1.221	0.910	1.056	0.333	0.499
	(.120)	(.170)	(.158)	(.017)	(.061)
University	1.994	0.370	0.430	0.401	0.660
	(.143)	(.187)	(.177)	(.024)	(.067)
Intercept	-2.588	---	---	10.034	9.918
	(.222)			(.034)	(.113)
First break	---	-1.853	-0.569	---	---
		(.353)	(.299)		
Second break	---	-1.610	-0.111	---	---
		(.350)	(.295)		
Third break	---	0.442	1.143	---	---
		(.343)	(.294)		
Fourth break	---	0.864	1.965	---	---
		(.343)	(.296)		
Pseudo R^2	0.082	0.104	0.054	0.131	0.107
Number of observations	5,185	2,802	2,383	2,771	2,328

Notes: Standard errors are in parentheses. All models are estimated using sampling weights. In column (1), the dependent variable equals 1 if the observation is from 1995–98, and 0 if from 1983–86, and the specification estimated is a Logit model. In columns (2) and (3), the dependent variable is defined in Table 3, and the specifications are Ordered Logit models. In columns (4) and (5), the dependent variable is log(household income), and the specifications are estimated using median regressions. See text for further details.

Table A1(c): Counterfactual analysis for single adult with children households

Variable	Attributes	Employment outcomes		Economic returns	
		1983–86	1995–98	1983–86	1995–98
	(1)	(2)	(3)	(4)	(5)
Female	-0.159	-1.964	-0.326	0.119	-0.065
	(.235)	(.366)	(.283)	(.038)	(.039)
Māori	0.875	-0.873	-0.459	-0.017	-0.034
	(.198)	(.377)	(.230)	(.030)	(.030)
Married	1.158	-0.399	-1.184	-0.327	0.069
	(.446)	(.683)	(.512)	(.063)	(.054)
Aged 25–39	1.376	1.029	1.624	0.049	-0.028
	(.652)	(1.72)	(1.12)	(.086)	(.111)
Aged 40–49	2.446	1.202	1.061	0.043	0.038
	(.785)	(1.86)	(1.23)	(.105)	(.132)
Aged 50+	1.460	-0.604	0.945	-0.102	-0.121
	(.997)	(2.16)	(1.43)	(.116)	(.177)
Highest qualification					
School	0.598	0.904	0.930	0.025	0.015
	(.170)	(.298)	(.224)	(.022)	(.031)
Vocational	0.779	1.166	0.985	0.116	0.092
	(.203)	(.325)	(.248)	(.030)	(.035)
University	0.978	2.096	1.142	0.496	0.208
	(.304)	(.470)	(.369)	(.040)	(.049)
Fraction of persons:					
Aged 0–4	3.616	-4.248	-4.697	-1.306	-0.672
	(1.06)	(2.29)	(1.54)	(.146)	(.180)
Aged 5–14	2.162	-0.206	-2.111	-1.082	-0.507
	(.843)	(1.93)	(1.29)	(.117)	(.148)
Aged 15–18	1.821	2.702	-1.431	-0.802	-0.177
	(.974)	(2.14)	(1.46)	(.140)	(.179)
Intercept	-1.872	---	---	10.247	10.208
	(.751)			(.107)	(.131)
First break	---	-1.127	-0.544	---	---
		(1.86)	(1.20)		
Second break	---	-0.381	0.664	---	---
		(1.86)	(1.20)		
Pseudo R^2	0.052	0.252	0.116	0.179	0.083
Number of observations	1,013	428	585	427	579

Notes: Standard errors are in parentheses. All models are estimated using sampling weights. In column (1), the dependent variable equals 1 if the observation is from 1995–98, and 0 if from 1983–86, and the specification estimated is a Logit model. In columns (2) and (3), the dependent variable is defined in Table 3, and the specifications are Ordered Logit models. In columns (4) and (5), the dependent variable is log(household income), and the specifications are estimated using median regressions. See text for further details.

Table A1(d): Counterfactual analysis for multiple adults with children households

Variable	Attributes	Employment outcomes		Economic returns	
		1983–86	1995–98	1983–86	1995–98
	(1)	(2)	(3)	(4)	(5)
Number of adults	-0.009	1.525	0.910	0.237	0.074
	(.058)	(.100)	(.083)	(.044)	(.025)
Fraction of adults:					
Female	0.999	-2.318	-1.851	0.381	-0.126
	(.265)	(.359)	(.341)	(.168)	(.053)
Māori	0.816	-0.235	-0.148	0.022	0.036
	(.109)	(.124)	(.134)	(.071)	(.043)
Married	-0.194	0.723	1.004	0.235	-0.126
	(.132)	(.160)	(.182)	(.057)	(.053)
Aged 15–18	0.089	-0.698	0.253	-0.508	-1.413
	(.442)	(.657)	(.575)	(.222)	(.178)
Aged 25–39	1.069	-0.103	1.273	0.647	-0.113
	(.294)	(.380)	(.404)	(.184)	(.116)
Aged 40–49	2.483	-0.539	1.691	0.728	0.039
	(.333)	(.421)	(.455)	(.198)	(.133)
Aged 50+	1.996	-2.542	-1.615	-0.031	0.148
	(.368)	(.477)	(.505)	(.239)	(.147)
Fraction of adults with highest qualifications:					
School	1.769	0.542	0.865	0.267	0.469
	(.102)	(.117)	(.127)	(.043)	(.042)
Vocational	1.099	0.408	0.939	0.364	0.564
	(.105)	(.125)	(.133)	(.050)	(.044)
University	2.023	0.505	0.514	0.598	0.863
	(.120)	(.132)	(.143)	(.053)	(.047)
Fraction of persons:					
Aged 0–4	1.307	-4.972	-2.641	-0.927	-1.716
	(.417)	(.509)	(.538)	(.234)	(.169)
Aged 5–14	0.893	-1.019	-0.606	-0.495	-1.126
	(.341)	(.427)	(.451)	(.215)	(.139)
Aged 15–18	0.312	1.527	-0.625	0.228	0.104
	(.551)	(.758)	(.702)	(.301)	(.234)
Intercept	-2.620	---	---	9.266	11.039
	(.392)			(.333)	(.159)
First break	---	-2.046	-0.138	---	---
		(.544)	(.542)		
Second break	---	-1.770	0.443	---	---
		(.542)	(.542)		
Third break	---	1.471	2.207	---	
		(.538)	(.544)		
Fourth break	---	2.448	3.549	---	
		(.539)	(.546)		
Pseudo R^2	0.080	0.136	0.073	0.185	0.132
Number of observations	6,741	4,008	2,733	3,941	2,681

Notes: Standard errors are in parentheses. All models are estimated using sampling weights. In column (1), the dependent variable equals 1 if the observation is from 1995–98, and 0 if from 1983–86, and the specification estimated is a Logit model. In columns (2) and (3), the dependent variable is defined in Table 3, and the specifications are Ordered Logit models. In columns (4) and (5), the dependent variable is log (household income), and the specifications are estimated using median regressions. See text for further details.

Table A2: Employment outcomes

Employment outcome	Single adult under 60 (1)	Multiple adults under 60 (2)	Single adult with kids (3)	Multiple adults with kids (4)
		1983–86		
0	0.173	0.039	0.591	0.037
1	0.034	0.010	0.108	0.009
2	0.792	0.195	0.301	0.364
3	---	0.070	---	0.184
4	---	0.687	---	0.406
		1989–92		
0	0.303	0.072	0.696	0.113
1	0.056	0.045	0.121	0.036
2	0.642	0.195	0.183	0.321
3	---	0.118	---	0.243
4	---	0.569	---	0.288
		1995–98		
0	0.215	0.052	0.615	0.091
1	0.086	0.049	0.197	0.050
2	0.699	0.143	0.188	0.288
3	---	0.152	---	0.273
4	---	0.604	---	0.298

Notes: All entries are fractions, and sum to one for each column within each block. The employment outcome category for each household type is defined according to the presence of part-time (PT) and full-time (FT) workers: '0' corresponds to no workers; '1' corresponds to any PT workers; '2' corresponds to a single FT worker; '3' corresponds to a single FT worker and any PT workers; '4' corresponds to at least two FT workers.

Motu Economic and Public Policy Research

Motu Economic and Public Policy is a non-profit Research Institute (Charitable Trust) that has been registered since 1 September, 2000. The Trust aims to promote well-informed and reasoned debate on public policy issues relevant to New Zealand decision making. Motu is independent and does not advocate an expressed ideology or political position.

Motu aims to enhance the economic research and policy environment in New Zealand by carrying out high quality independent research, teaching through universities and other institutions, training junior research staff, facilitating networks of researchers, hosting foreign researchers and organising small conferences and dialogue groups. It is our belief that objective research and analysis is a critical foundation for making informed policy decisions and we are committed to wide dissemination of our work.

Motu's primary strength lies in its people. All of our principal researchers have PhDs in economics from top international universities as well as extensive public policy-related work experience. Our distinctive contribution is an emphasis on sound empirical analysis, supported by our expertise in and knowledge of economic theory and institutional design. We choose research areas that build on the interests and expertise of our principal researchers. Our current priorities are in the areas of environmental regulation, labour and social policy, and macroeconomics.

We maintain strong links with a large pool of internationally renowned experts in our chosen fields. These international linkages are critical to our success, and one of our major contributions to New Zealand.

Our research funding is primarily in the form of research grants. We see this as a means of maintaining our commitment to the quality and objectivity of our research. We are able to compete internationally for such funding because of the calibre of our principal researchers and because of international fascination with the New Zealand reforms. Some of our funding comes from foreign foundations and governments. This serves not only to expand the available pool of research on New Zealand policy issues, but also to stimulate wider interest in these issues. We also seek unrestricted funding from individuals, foundations and corporations to allow us to build a stronger research infrastructure within Motu and the wider research community. This allows us to actively disseminate ideas, create longer term independent research programs that do not meet short-term funding priorities, and organise networks and conferences involving other researchers and policy analysts.

Motu purposes

1. Carrying out and facilitating empirical and theoretical research on public policy issues relevant to New Zealand; the quality of the research will meet international academic standards, suitable for acceptance in reputable academic journals.
2. Making existing knowledge more accessible for policy debates in New Zealand; this may be done by summarising and critically reviewing existing work on public policy issues, or by contributing to and facilitating policy discussions through seminars, workshops, and dialogue groups.
3. Disseminating the results of our work and knowledge through publication (particularly in refereed publications), the internet, conferences, seminars, workshops, dialogue groups, and teaching.
4. Building New Zealand capacity to carry out empirical and theoretical research on New Zealand public policy. This will be done through means such as training, collaboration, sponsorship of students or researchers and development of New Zealand databases.
5. Maintaining close links with international experts working on topics related to our purpose through communication and collaboration.
6. Advancing our work and purpose within New Zealand by facilitating the visits of relevant international visitors.

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