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WORKING PAPER 10/2022
March 2022

Working Papers in Public Finance

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Further enquiries to:
The Administrator
Chair in Public Finance
Victoria University of Wellington
PO Box 600
Wellington 6041
New Zealand

Phone: +64-4-463-9656
Email: cpf-info@vuw.ac.nz

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Measuring Positional Changes within the New Zealand Income Distribution: Evidence from Administrative Data*

Nazila Alinaghi, John Creedy and Norman Gemmell†

Abstract

This paper uses administrative, longitudinal data on the New Zealand taxpayer population to examine the nature and extent of positional changes within the income distribution by individuals. It uses recently developed devices for illustrating re-ranking over time, for periods of 1 to 15 years, during 2002 to 2017. The results, for a range of population groups, highlight the fact that there is a high degree of re-ranking by individuals within the income distribution. After 15 years, re-ranking of individuals' incomes represent around 30 to 45 per cent of the maximum re-ranking possible.

JEL Classification: D31, I32

Keywords: Income mobility; re-ranking

*This paper is part of a project on 'Measuring Income Inequality, Poverty, and Mobility in New Zealand', funded by an Endeavour Research Grant from the Ministry of Business, Innovation and Employment (MBIE) and awarded to the Chair in Public Finance at Victoria University of Wellington.

†Victoria University of Wellington

Disclaimer

Results reported below are based in part on tax data supplied by Inland Revenue to Statistics New Zealand (SNZ) under the Tax Administration Act 1994 for statistical purposes. Any discussion of data limitations or weakness is in the context of using the IDI for statistical purposes, and is not related to the data's ability to support Inland Revenue's core operational requirements. Access to the data used in this study was provided by SNZ under conditions designed to give effect for the security and confidentiality provisions of the Statistics Act 1975. The results presented in this study are the work of the authors, not SNZ or individual data suppliers. These results are not official statistics. They have been created for research purpose from the Integrated Data Infrastructure and/or Longitudinal Business Database which are carefully managed by SNZ. More information about these databases can be obtained at: *https://www.stats.govt.nz/integrated-data/*.

1 Introduction

This paper uses administrative, longitudinal data on the taxpayer population to examine the nature and extent of individuals' positional changes within the New Zealand income distribution, over the period 2002 to 2017.[1] The construction of the special dataset has been made possible due to the improved availability of anonymised administrative register data, such as from individuals' tax records, in New Zealand's Integrated Data Infrastructure (IDI). These administrative data sources provide several advantages compared with sample surveys. Administrative data have very large sample sizes, improved coverage of top incomes, avoidance of survey respondent dropout or attrition, and less measurement errors. While recognising the limitations of such data, for example the absence of information on non-taxable income, the dataset used in this paper nevertheless provides the most comprehensive information to date on NZ taxpayers' incomes, suitable for inequality and mobility analysis.[2]

The focus of the paper is on the construction of diagrams which succinctly convey the nature of mobility as positional change. The diagrams illustrate 'at a glance' the re-ranking changes taking place within cohorts over time. These diagrams were first introduced by Creedy and Gemmell (2019a). The first is a 'cumulative re-ranking curve', which considers the cumulative observed re-ranking across individuals, ranked in ascending order of their position in the initial income distribution. The second is a 're-ranking ratio' (RRR) curve, which compares the ratio of observed re-ranking to the maximum feasible re-ranking for each individual (since the maximum differs across individuals).[3] In describing the nature of mobility, no attempt is made here

[1] A companion paper examines mobility in terms of differential income growth, using 'Three Is of Mobility' (TIM) curves; see Alinaghi *et al.* (2022c).

[2] Income mobility is of course only one aspect of more general social mobility, including intergenerational, as well as intra-generational, mobility. While income mobility is relatively easy to measure and quantify, it does not seek to capture broader dimensions of mobility such as that associated with changes in social class, educational or occupational status; see Simandan (2018), the contributions by Atkinson and Goldthorpe in Svallfors (2005) and Markandya (1982) for further discussion.

[3] The various illustrative devices avoid an attempt to produce an overall measure of mobility. A simple approach, for example, would involve the proportion of off-diagonal entries in a transition matrix. Shorrocks (1978) proposed a mobility measure in terms of 'the degree to which equalisation occurs as the observation period is extended' (p.386). Using New Zealand taxpayer income data from 1994 to 2012, Creedy and Gemmell (2019a) and Creedy *et al.* (2021) report reductions in Gini and Atkinson inequality indices as the accounting period is lengthened from one year to up to 19 years (from different starting dates). Alinaghi *et al.* (2022a) perform a similar exercise using more recent

to distinguish changes which are regarded by the individuals concerned – or indeed policy-makers – either as desirable or undesirable.[4]

The positional change mobility diagrams are defined in Section 2. These new devices are applied to the special longitudinal dataset of individual taxpayers in New Zealand, summarised in Section 3. Empirical results for taxpayers as a whole, and for various sub-groups, are reported in Section 4. Conclusions are in Section 5.

2 Positional Mobility

This section describes an approach to illustrating mobility, based on the idea of mobility as positional change.[5] The diagrams were first proposed and illustrated by Creedy and Gemmell (2019a). Individuals can obviously move to higher or lower positions, so the explicit treatment of the *direction* of change is necessary. In the following, individuals are ranked in ascending order of initial incomes, $x_{i,0}$, so that $i = 1, ..., n$ orders individuals from the lowest to the highest income. The initial period is 0, and initial ranks are $R_{i,0} = i$. First, a choice must be made regarding *whose* mobility to be included. Here, concentration is on a subset of individuals, $k \leq n$, with the lowest initial incomes. Second, it is necessary to decide whether negative re-ranking (dropping down the ranking) is treated symmetrically with upward (positive) movement.

Let $\Delta R_i = R_{i,1} - R_{i,0} = R_{i,1} - i$ denote the change in the rank of the person who initially has rank, i. Three options are possible, depending on how negative re-ranking is treated. First, negative re-ranking can be treated symmetrically with positive re-ranking such that positional mobility is defined in *net* terms, that is, positive changes in rank net of any negative changes within group $i = 1, ..., k$.[6] This is referred to as '*net*

and more comprehensive taxpayer data.

[4]Following Fields (2000), a number of authors have pointed to the normative ambiguity associated with (possibly desirable) flexibility in long-term income movements versus (undesirable) short-term volatility. Jäntti and Jenkins (2015) suggest that the concept of income risk can be regarded as one component of longer term income inequality. In this view, changes in an income inequality measure over time have both permanent predictable, and transitory unpredictable, components. They label the latter as 'income risk'.

[5]D'Agostino and Dardanoni (2009) and Cowell and Flachaire (2016) have sought to re-define and clarify various rank-related mobility concepts and measures. Cowell and Flachair (2016) propose a 'superclass' of rank-based measures. They stress the importance of separating the evaluation of an individual's positional 'status' from movements between positions, where measurement of the latter uses distance concepts. However, neither study offers graphical devices to illustrate the measures.

[6]If individual changes in rank are simply aggregated to obtain an aggregate mobility index, then a

re-ranking'. Secondly, negative movements could be ignored, which simply involves setting $\Delta R_i = 0$ when $\Delta R_i < 0$: this is referred to as '*positive* re-ranking'. Thirdly, re-ranking may be measured in *absolute* terms in which all re-ranking is positive: this is referred to as '*absolute* re-ranking'. The choice among these three measures depends on the question of interest. For example, if interest is focussed on those below the poverty line *as a group*, then it may be desirable to balance any upward mobility by some of those in poverty with downward mobility of others in poverty, to gain an indication of the net experience of the group. This suggests a focus on net mobility. If movement *per se* is the mobility concept of interest, a non-directional measure such as absolute re-ranking is relevant. Positive re-ranking quantifies only those who are moving up, a common metric when assessing the persistence of low income or poverty.[7]

The three re-ranking indices individual, i, can be defined formally (where pos = positive; abs = absolute) as $M_i^{net} = \Delta R_i$, $M_i^{pos} = \Delta R_i|_{\Delta R_i \geqslant 0}$, and $M_i^{abs} = |\Delta R_i|$. Cumulated across the k lowest income individuals in period 0, the corresponding aggregate re-ranking indices are:[8]

$$M_k^{net} = \sum_{i=1}^{k} M_i^{net} = \sum_{i=1}^{k} (R_{i,1} - R_{i,0}) \tag{1}$$

$$M_k^{pos} = \sum_{i=1}^{k} M_i^{pos} = \sum_{i=1}^{k} (R_{i,1} - R_{i,0}) \quad \text{for} \quad \Delta R_i \geqslant 0 \tag{2}$$

$$M_k^{abs} = \sum_{i=1}^{k} M_i^{abs} = \sum_{i=1}^{k} |R_{i,1} - R_{i,0}| \tag{3}$$

To examine the incidence, intensity and inequality of positional mobility, using (1), (2) and (3), one approach would be to plot the value of the relevant M_k index against the cumulative fraction of the population, $h = k/n$. However, there are two difficulties with the indices in (1) to (3). First, they are not scale independent, since they depend

change in rank of 50 places by one individual is treated symetrically as 50 individuals each changing one ranking place.

[7] On poverty persistence, see Creedy and Gemmell (2018).

[8] The absolute re-ranking case may be thought of as describing overall positional change within the relevant income range. Over short periods this is often described as volatility, or 'income risk', with a presumption that, *ceteris paribus*, less risk is preferable to more risk. Over longer time periods it may be regarded as describing the flexibility of the income distribution. This has less-clear welfare associations, although greater long-term mobility is often characterised as implying less-intrenched social inequalities.

on k and hence population size, as more re-ranking is possible in larger populations. One solution would be to scale the three M_k indices by n. However, as is shown below, a slightly different rescaling, by $(n/2)^2$, yields normalised values, m_k, that lie between zero and one (or zero and two for positive re-ranking). These may be plotted against $0 \leqslant h \leqslant 1$.

Secondly, an individual's *opportunity* for re-ranking is partly determined by the initial position: someone among the lowest ranks has less opportunity to move down, other things equal, than someone higher up, and *vice versa*. It is therefore useful to consider the maximum re-ranking possible for each individual; actual re-ranking may then be compared with these maximum values for any given h.

Consider first the maximum re-ranking and, to simplify the exposition, consider a population of $n = 100$ individuals, each with a different income level; hence each integer, $i = 1, ..., n$, represents a percentile. They are ranked in period 0, $R_{i,0} = 1 \ldots 100$, representing the lowest to the highest incomes. Two polar cases are the maximum and minimum degrees of mobility possible. The former is defined here as a complete ranking reversal, $\Delta R_i(\max)$, such that in period 1, $R_{i,1}$ involves a lowest to highest ranking of $R_{i,1}(\max) = n + 1 - R_{i,0} = 100, \ldots, 1$.[9] Maximum re-ranking implies:

$$M_i(\max) = \Delta R_i(\max) = R_{i,1}(\max) - R_{i,0} = n + 1 - 2R_{i,0} \tag{4}$$

which, for large n, can be approximated by $n - 2R_{i,0}$. Where it is desired to measure the extent of re-ranking of the subset of individuals, $k \leq n$, with the lowest incomes, the cumulative maximum re-ranking index for the net mobility case , $M_{k}^{net}(\max)$, is:

$$M_{k}^{net}(\max) = \sum_{i=1}^{k} M_{i}^{net}(\max) = \sum_{i=1}^{k}(n + 1 - 2R_{i,0}) \tag{5}$$

Using the sum of an arithmetic progression, whereby $\sum_{i=1}^{k} R_{i,0} = 1 + 2 + \ldots + k = k(k+1)/2$, equation (5) becomes:

$$M_{k}^{net}(\max) = \sum_{i=1}^{k}(n + 1 - 2R_{i,0}) = k(n+1) - k(k+1) = k(n-k) \tag{6}$$

[9] Jantti and Jenkins (2015; pp. 8-9) proposed that the relevant comparator should be defined as when the change in an individual's position is purely random. That is, 'maximum' mobility involves independence from initial positions, rather than complete reversals. They reject the use of 'maximum' when mobility is based on origin independence.

Hence, in the $n = 100$ example above, if interest focuses only on the poorest individual ($k = 1$), maximum net re-ranking is given by $M_k^{net}(\max) = (100 - 1) = 99$; when $k = 2$, $M_k^{net}(\max) = 2(100 - 2) = 196$; and so on. More generally, since maximum re-ranking (complete ranking reversal) involves all those below the median individual changing positions with those above the median, it follows from (6) that the maximum value of $M_k^{net}(\max)$ as k increases is obtained for $k = n/2$, yielding $M_k^{net}(\max) = (n/2)^2$.[10]

This measure therefore serves to highlight the scale dependence of both M_k^{net} and $M_k^{net}(\max)$: larger populations imply larger values of both indices. These could be 'normalised' to create a form of per capita index by dividing by n^2 such that, from (6), the index becomes: $m_k^{net}(\max) = h(1 - h)$. The maximum value would be reached at $h = 0.5$, where $m_k^{net}(\max) = 0.25$. However, to get an index with a maximum value of 1 (at $k = n/2$) , it is preferable to divide by $(n/2)^2$. That is:

$$m_k^{net}(\max) = 4M_k^{net}(\max)/n^2 \tag{7}$$

Using (6):

$$m_k^{net}(\max) = 4h(1 - h) \tag{8}$$

A similar exercise for positive re-ranking, $M_k^{pos}(\max)$, shows that the value of $M_k^{pos}(\max)$ also reaches a maximum as k increases of $M_k^{pos}(\max) = n^2/4$ when $k = n/2$, since all individuals below $n/2$ experience positive re-ranking in this (maximum) case. However, above $k = n/2$, as more above-median individuals are included within k, their re-rankings are now given by $\Delta R_i = 0$, such that the cumulative index, $M_k^{pos}(\max)$, remains unchanged as $k \longrightarrow n$. Thus a similarly rescaled $m_k^{pos}(\max)$ may be defined analogously to (7) to yield a positive re-ranking index where $0 \leqslant m_k^{pos}(\max) \leqslant 1$.

Finally, for the absolute re-ranking case in (3), $M_k^{abs}(\max)$, this increases as k increases from $k = 1$ to $k = n/2$ to reach $M_k^{abs}(\max) = (n/2)^2$. However, this is a point of inflection rather than a maximum, since inclusion of the absolute value of above-median individuals' re-ranking in $M_k^{abs}(\max)$, ensures that $M_k^{abs}(\max)$ continues to increase for $k > n/2$, reaching $M_k^{abs}(\max) = n^2/2$ at $k = n$. Hence, an absolute re-ranking index $m_k^{abs}(\max)$ obtained by rescaling by $(n/2)^2$ lies between zero and two.

[10] Strictly, for small n, the median individual is $k = (n + 1)/2$, and $M_k^{net}(\max)$ is given by $(n + 1)(n - 1)/4$.

Finally, to compare actual and maximum re-ranking mobility, the expressions for actual mobility in (1) to (3) can be similarly rescaled or normalised by $(n/2)^2$ to obtain actual aggregate re-ranking mobility expressions, m_k^{net}, m_k^{pos}, and m_k^{abs}, given in each case by:

$$m_k = 4M_k/n^2 \tag{9}$$

Thus, $0 \leqslant m_k^{net}, m_k^{pos} \leqslant 1$ and $0 \leqslant m_k^{abs} \leqslant 2$. This suggests a convenient illustrative device for positional mobility is a cumulative re-ranking curve that plots m_k against h.

2.1 Maximum Re-Ranking profiles

Profiles for the three (rescaled) maximum re-ranking cases discussed above, $m_k^{net}(\max)$, $m_k^{pos}(\max)$, and $m_k^{abs}(\max)$ are plotted against $h = k/n$ in Figure 1. This shows the distinct non-linear shape of the maximum profiles, whichever definition of positional mobility is adopted – net, positive or absolute. As expected, the net re-ranking profile displays a parabolic shape which differentiation of (8) reveals has a slope of $4(1 - 2h)$; hence equals zero at $h = 0.5$ (the 50^{th} percentile), thereafter declining symmetrically to a slope of -4 at $h = 1$. The equivalent positive re-ranking profile also reaches a maximum at the 50^{th} percentile but remains constant thereafter, while the absolute re-ranking profile displays a sigmoid shape, reaching a local point of inflection where $m_k^{abs}(\max) = 1$ at the 50^{th} percentile, but then rising at an increasing rate till $m_k^{abs}(\max) = 2$ at $h = 1$.

The maximum re-ranking indices in Figure 1 are invariant to population size, but vary with the population percentile, of interest, h. Thus, the *scope* for a given degree of re-ranking also varies with h. A natural index of interest therefore is the ratio of actual to maximum mobility at each percentile, h. This is referred to below as the 're-ranking ratio', RRR_k, and can be calculated for net, positive and absolute re-ranking. For example, the net re-ranking case is given by:

$$RRR_k^{net} = \frac{m_k^{net}}{m_k^{net}(\max)} = \frac{M_k^{net}}{M_k^{net}(\max)} \tag{10}$$

where the numerator and denominator are given respectively by (9) and (7), or by (1) and (6). This ratio can also be plotted against h to identify how the extent of mobility changes by percentile of the population relative to the maximum possible *for that percentile*. Recognising these differences in maximum re-ranking is important when

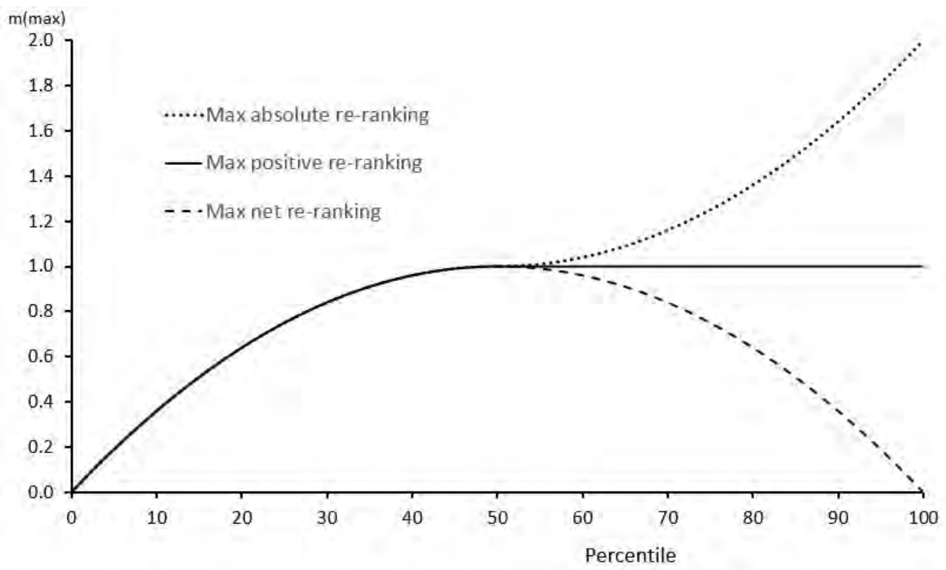

Figure 1: Maximum Re-ranking

interpreting differences in actual re-ranking for different values of h. In particular, a smaller value of m_k^{net} at $h = 0.1$, compared to m_k^{net} at $h = 0.3$, for example, may be partly or entirely due the fact that individuals up to $h = 0.1$ cannot achieve the higher m_k^{net} observed at $h = 0.3$, even in the absence of other constraints on re-ranking mobility.

3 The Longitudinal Dataset

This section summarises the longitudinal dataset used below: a detailed description and explanation of its construction is given in Alinaghi *et al.* (2020). The dataset has been made possible by the improved availability of anonymised administrative register data, such as from individuals' tax records, in New Zealand's Integrated Data Infrastructure (IDI). This has facilitated the construction of longitudinal data through the matching of income records for individuals over time. These data sources provide several advantages compared to surveys, such as very large sample sizes, improved coverage of top incomes, avoidance of survey respondent dropout or attrition, and less measurement error. The data used in this paper provides the most comprehensive information to date on NZ taxpayers' incomes, suitable for inequality and mobility analysis.

A number of administrative datasets within the IDI were merged to form the final dataset used here. The primary database covers the Inland Revenue individual taxpayer population, containing detailed tax return and PAYE information such as wage and salary earnings, self-employment income, pensions, and capital income. Socioeconomic variables such as gender, age, ethnicity and highest educational qualification were then added to the primary dataset. From a population of around 5.4 million taxpayer observations for whom there is taxable income information in the IDI for at least one year of data over the 18 years 2000 to 2017, a sub-sample of around 1.5 million individuals is available with income data for all 18 years.

For the present exercise it was decided to start with the income distribution in 2002 rather than 2000, thus covering 16 years of income data, or 15 years of income growth for all individuals. This reduces the sample size slightly, to around 1.450 million individuals, but avoids potential distortions associated with the 2000-2001 years when reforms to the top personal income tax rate are known to have caused annual taxpayer incomes, especially towards the top of the income distribution, to fluctuate temporarily; see Creedy *et al.* (2021).

Table 1 shows some decompositions of the total taxpayer population with annual data over the 2002 to 2017 period, by gender, age, ethnicity and highest educational qualifications. This indicates that the gender composition is close to 50:50 between males and females. Māori and Pasifika represent around 14 per cent and 4 per cent respectively of all individuals. Other ethnicities recorded in the dataset include European, Asian, Middle Eastern/Latin American/African and 'Other' (miscellaneous) represent the remaining 86 per cent.[11]

For longitudinal data covering a large number of years, defining the working age group is not straightforward. The table shows outcomes using two definitions. The

[11] In the 2018 New Zealand census, out of a total population of 4,699,755 individuals, ethnicity percentages were as follows: European (70), Māori (17), Pasifika (8), Asian (15), MELAA (Middle Eastern, Latin American, and African) (1), Others (1). These percentages add to more than 100 percent because individuals are able to specify more than one ethnicity. In the dataset used here a single 'prioritised ethnicity variable' has been created by assigning ethnicity to each individual according to the following priority ordering: Māori, Pacific Peoples, Asian, European, MELAA, and Other. For example, an individual is classified as Māori, if their ethnic code in one of the three data sources is Māori. This process is repeated for other ethnic groups in order; see Alinaghi *et al.* (2020, p.11-12) for further details.

first case defines working age individuals as those aged 20 to 64 in 2002.[12] This may be regarded as most suitable for mobility measured over 1 year, for example, 2002 to 2003. The second working age definition considers only those aged 20-64 in all years 2002 to 2017, hence including only those aged 20-49 in 2002. These two definitions yield working age sub-groups of 86 per cent of the total sample (1.248 million) and 63 per cent of the total (0.912 million) respectively.

For educational qualification decompositions in Table 1, data on highest educational qualification are constructed such that individuals are assigned to a category according to their highest qualification obtained in any year during the 2002 to 2017 period. For example, an individual obtaining a university degree in 2005 is allocated to this category throughout the period examined. This avoids changes in sub-sample sizes for each qualification category during the period, and reflects the interest here in an income decomposition based on an individual's educational capability or potential (as demonstrated by their highest qualification) rather than distinguishing incomes pre- and post-qualification.[13]

Around 20 per cent of the total have no qualifications (250,140 individuals). This is similar to those with university degrees (18 per cent), while individuals with 'school' and 'post-school' qualifications represent around 36 and 26 per cent of the total respectively. 'Post-school' qualifications include diplomas and other non-degree qualifications from higher education institutions such as technical colleges and Wānanga.

4 Re-ranking Mobility in New Zealand

This section reports positional change diagrams, described in Section 2, for New Zealand data, to assess both the extent of observed positional mobility and its incidence, intensity and interpersonal dimensions. This is illustrated first by plotting the re-ranking measures m_k^{pos}, m_k^{net} and m_k^{abs} against h, analogous to the $m_k(\max)$ profiles in Figure 1.

[12] Of course actual working ages differ across individuals with many working, especially part-time, before age 20 and after age 64. The relatively restrictive working age definition of 20-64 aims to focus attention on those most likely to be permanently attached to the workforce, after any post-school education and prior to receipt of New Zealand Superannuation.

[13] Some individuals may go on to obtain an additional, higher qualification in the years after the final year of the dataset in 2017, which obviously cannot be captured here.

Table 1: Sample Sizes by Decomposition

	Sample size		Sample size
Gender:		Ethnicity:	
Male	736,371	Māori	200,451
Female	711,384	Pasifika	64,692
		Non-Māori, non-Pas.	1,182,612
Total	1,447,755	Total	1,447,755
Age:		Educational Qualifications:**	
Working*	1,248,510	None	250,140
Non-working	214,239	School	457,917
Working§	912,018	Post-school	325,521
Non-working	535,737	University	222,543
Total	1,447,755	Total	1,256,121

*Ages 20-64 in 2002. §Ages 20-64 in all years, 2002-2017.

**Educational sub-totals sum to smaller total due to missing qualifications data for some individuals.

To save space, in Figure 2 these are shown for the short 5-year period, 2002 to 2007, and the longest period of 15 years to 2017. This illustrates the nonlinear and quasi-linear nature of the various profiles. In each case, these profiles could contain concave, linear or convex segments, reflecting the degree of re-ranking being experienced as h is increased to include higher-income individuals. A greater amount of re-ranking mobility tends to generate profiles that are more concave. That is, greater concavity implies more-equalising positional mobility. Convexity implies disequalising re-ranking, with neutrality captured by linear segments.

It can be seen in Figure 2 that the three re-ranking curves (absolute, positive and net) have similar shapes in both periods, but differ largely in the magnitudes of re-ranking as shown by the vertical axis scales. Note that the maximum re-ranking possible is 1 (positive and net) or 2 (absolute). Thus, for the whole population of individuals, absolute re-ranking reaches around 0.6 after 5 years and exceeds 0.8 after 15 years (at the 100^{th} percentile). Similarly positive re-ranking reaches around 0.3 and 0.4 respectively.

To assess the incidence, intensity and interpersonal aspects of these re-ranking measures, Figure 2 should be interpreted as follows. For a given definition of positional mobility (net, positive or absolute re-ranking), select a value of $h = k/n$ representing

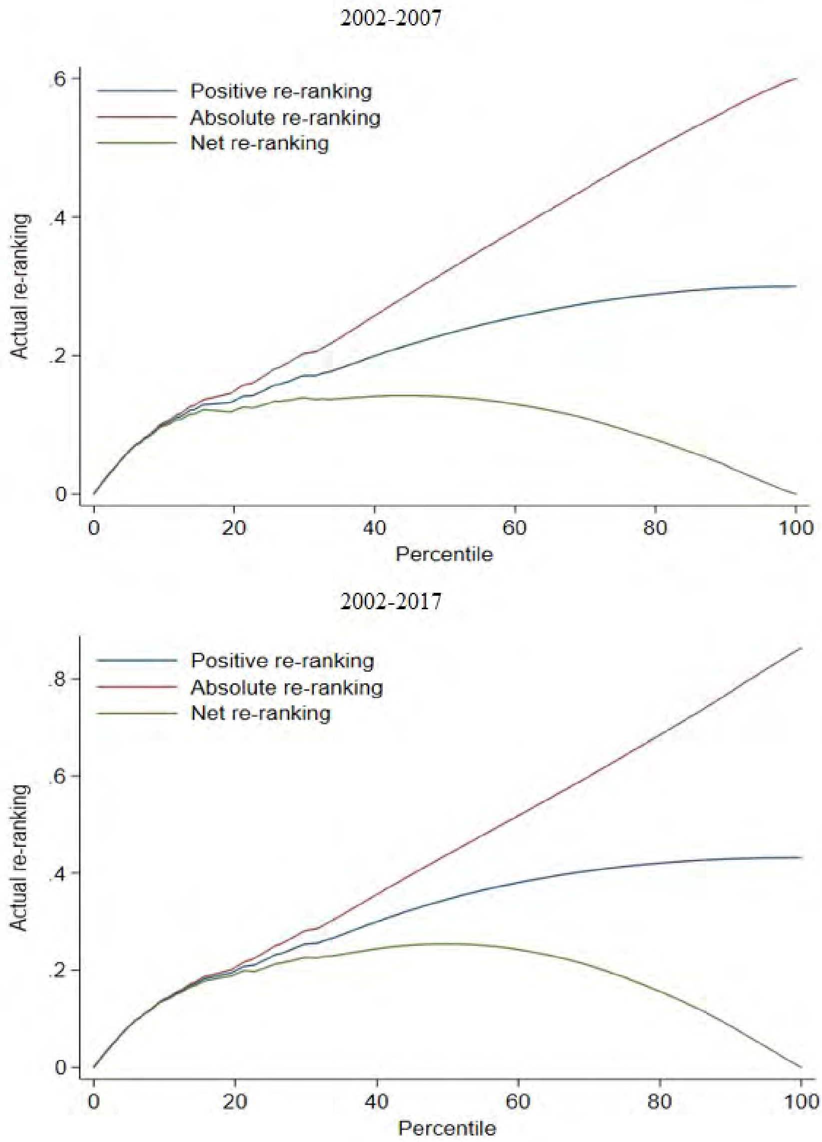

Figure 2: Re-rankng Curves, 2002-07 and 2002-17

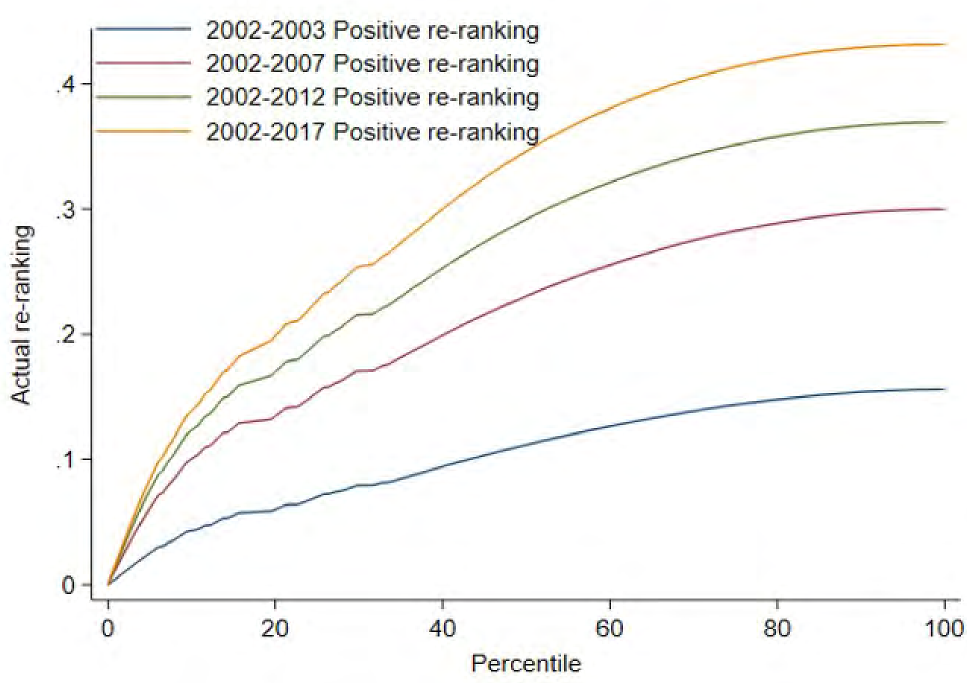

Figure 3: Absolute Re-ranking Across the Four Periods

the subset of low-income individuals of interest (the incidence dimension). The height of the profile on the vertical axis at this value of h represents the intensity of re-ranking for this group; namely how much re-ranking they have experienced on average (or cumulatively). The section of the profile to the right of h becomes irrelevant.

The deviation from linearity of the m_k profile, from the origin to its value at the selected h, provides a measure of the degree of progressive (concave) or regressive (convex) re-ranking among individuals within the h^{th} percentile. That is, the actual profile may be compared to a straight line from the origin to the value of m_k at $h = 1$. For example, in Figure 2 the profiles for absolute re-ranking are remarkably linear, at least above the 10^{th} percentile. This suggests that, at least for this sample and measure, the extent of re-ranking is relatively constant across the income distribution.

Changes in the incidence, intensity and inequality of positional mobility associated with different time periods can be examined by plotting relevant m_k profiles for the four periods. Figure 3 illustrates this for the positive re-ranking measure, m_h^{pos}; absolute and net re-ranking measures display similar properties. As expected, these profiles shift upwards (indicating more re-ranking) the longer the period of time considered. The largest increase appears to be between the 1-year and 5-year periods, with total re-ranking at the 100^{th} percentile around 0.15 (15 per cent) after 1 year and 0.3 after 5 years. By 15 years this has reached over 0.4.

It is clear from Figure 3 that the characteristics of re-ranking mobility across the four periods are very similar in terms of the interpersonal dispersion of mobility (concavity) of each profile for any given percentile, h. Also, since the maximum positive re-ranking for $h \geqslant 0.5$ is equal to one (see Figure 1), the values of m_k in Figure 3 also reveal the values of the re-ranking ratio, $RRR_k = m_k/m_k(\max)$ for $h \geqslant 0.5$. The RRR_k profiles look very different at lower values of h, and for different net/positive/absolute concepts, as shown below. Thus, at $h = 1$, the value of m_h^{pos} in excess of 0.4 for 2002-2017 suggests that over the 15 years, more than 40 per cent of the maximum potential re-ranking occurred.

As shown above, while some groups of individuals in Figures 2 and 3 may experience higher re-ranking than others, their movements are constrained to differing degrees by the maximum re-ranking possible. However, the differences between the actual m_k and the equivalent $m_k(\max)$ can be identified by considering changes in RRR_k as $h \longrightarrow 1$. Re-ranking ratio curves, obtained by plotting RRR_k against h, are shown in Figure 4 for the three re-ranking measures over 2002-2007 (upper panel) and 2002-2017 (lower panel): values on the vertical axis are simply the ratios of the axis values in Figures 2 and 1.

The chart indicates that, for all three re-ranking measures in the New Zealand case, the extent of mobility relative to the maximum achievable is relatively high for the lowest-income individuals (low h), with $RRR_k \approx 0.4$ after 15 years for $h \approx 0.1$. This steadily declines as h is increased, reaching a minimum of approximately 0.3 at around the 20^{th} to 30^{th} percentiles, except in the case of the m_h^{net} profile which continues to decline but remains fairly flat for $h > 0.3$. Thereafter, the RRR_k^{abs} rises to around the 70^{th} percentile, while the RRR_k^{pos} profile continues to rise to the 100^{th} percentile.[14]

It may therefore be inferred that the group experiencing absolute re-ranking that is closest to the maximum achievable are the very low-income group and also the middle-income group between approximately the 40^{th} and 70^{th} percentiles where the RRR_k^{pos} curve is rising most steeply towards a (local) maximum at $h = 1$. For the positive re-ranking measure, the ratio of actual to maximum re-ranking is generally highest for both the low and high population percentiles, reaching around $RRR_k^{pos} = 0.3$ or more after 5 years and $RRR_k^{pos} = 0.40$ or more after 15 years. From Figure 4, the RRR_k^{pos} and the RRR_k^{abs} profiles reach the same value for $h = 1$. As Creedy and Gemmell (2019) show, this is not a coincidence, but reflects the properties of the two measures.

Considering the three profiles in Figure 4 it is clear that the measure of net movement, RRR_k^{net}, indicates a persistent downward trend as h moves towards 1. This suggests that the lowest-income individuals generally experienced more movement in their income rank over this period, relative to the maximum achievable, than those on higher incomes. This seems likely to be capturing a re-ranking analogue of the progressivity in income growth, observed in Alinaghi et al. (2022c).

[14] The strong fluctuations in the curves, at h close to 1, relfect the fact that the value of both the actual and maximum net re-ranking measures equal zero at $h = 1$. Hence the ratio can be quite unstable in the vacinity of $h = 1$ (and is undefined at $h = 1$).

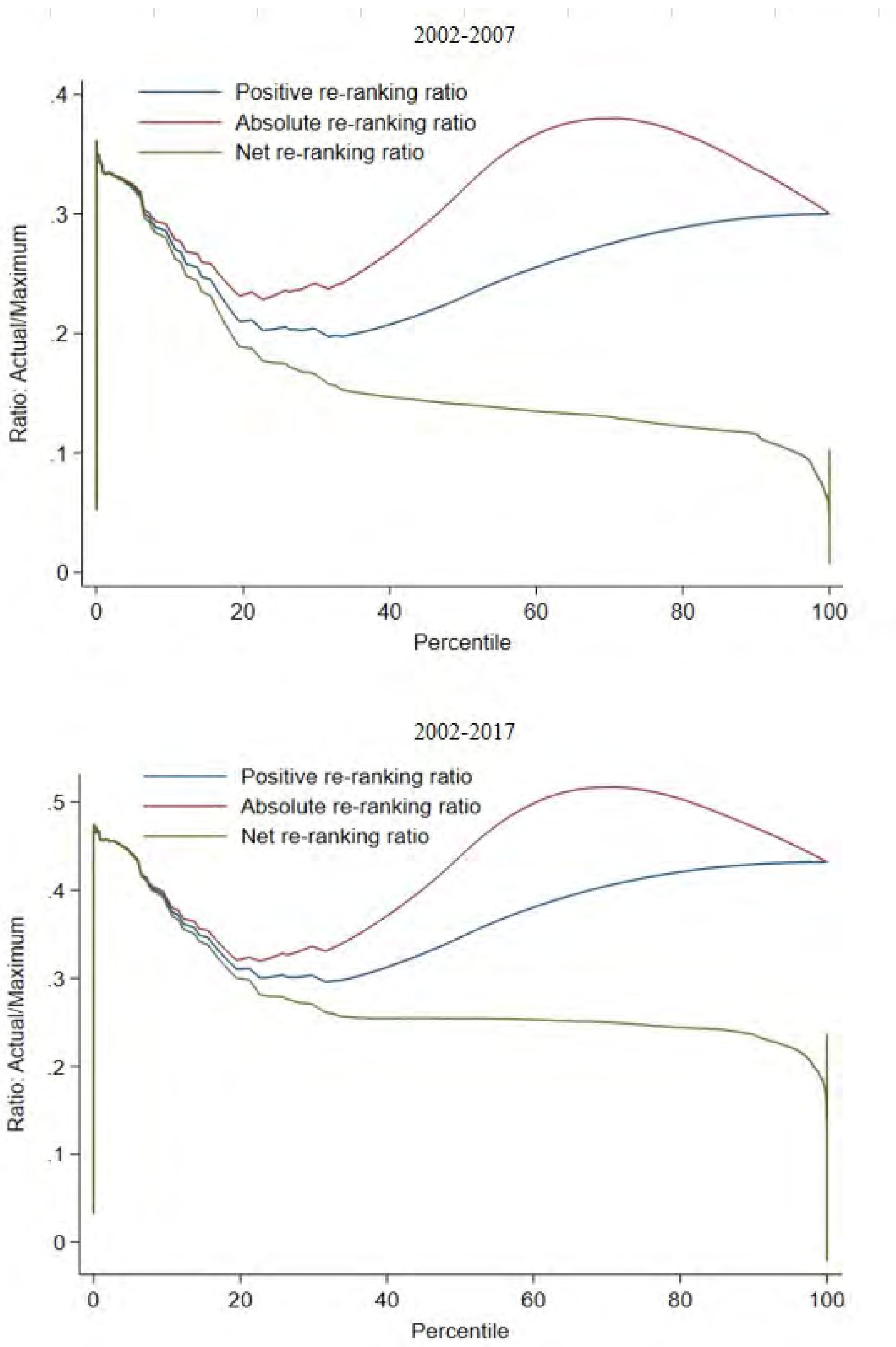

Figure 4: Re-ranking Ratio Curves, 2002-07 and 2002-17

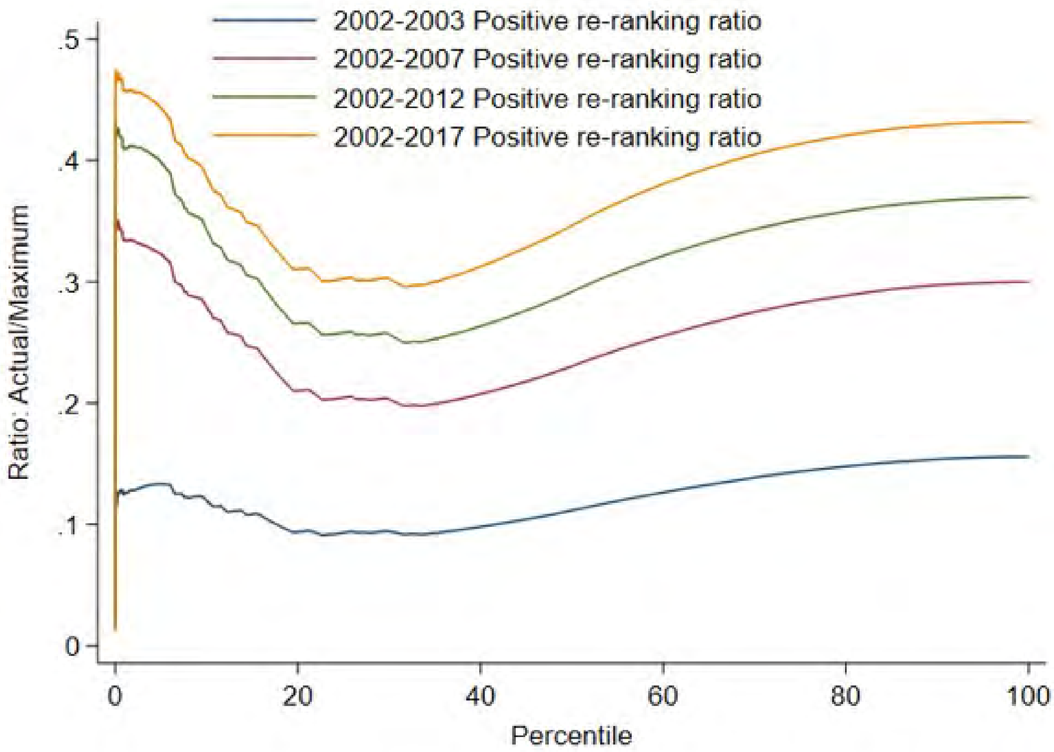

Figure 5: Positive Re-ranking Ratio Curves for Four Periods, 2002 to 2017

The tendency for the ratio of actual to maximum possible re-ranking to rise, the longer the time period considered, can be seen for the positive re-ranking measure in Figure 5, which includes all four RRR_k^{pos} profiles. This reveals the volatility in RRR_k over the lowest 5 percentiles, perhaps not surprisingly given the numbers of individuals in each period on very low incomes in the initial year (for example, in 2002, the 5^{th} percentile income level is only around $7,098), but who experience a wide range of income changes over the period. Much of this probably reflects some low-income individuals such as secondary earners, moving into employment or from part-time to full-time work, while others remain in their initial employment status. These data also include the self-employed who are known to experience greater annual income volatility.

All four profiles in Figure 5 behave similarly to the m_k^{pos} profiles in Figure 4, confirming greater re-ranking as a fraction of the maximum possible as more years are added. For example, the minimum RRR_k^{pos} occurs at around the 30^{th} percentile in all four profiles; it is approximately 0.1 after 1 year, rising to 0.3 after 15 years. Similarly the maximum RRR_k^{pos} values at very low percentiles rise from around 0.13 after 1 year to 0.45 after 15 years.

Figure 5 also suggests that the differences in RRR_k^{pos} across the percentiles tends to become more pronounced the longer the period considered. For example, re-ranking that occurs over just 1 year appears quite similar across all h values, at around 0.10 to 0.15. After 5 years, however, substantial differences across h values appear, ranging from 0.20 to 0.35. The results also demonstrate that, across an extended period of 15 years, positive re-ranking is typically around 30-45 percent of the maximum mobility possible, conditional on an individual's position in the initial income distribution. In all periods, it also tends to be highest at both the bottom and at the top of those initial distributions.

4.1 Re-ranking Ratio Curves by Gender, Ethnicity and Education

Changes in the incidence, intensity and inequality of positional mobility associated with different decompositions can be examined by plotting relevant re-ranking profiles over the short- and long-run. Figure 6 compares profiles for $RRR^{pos}$for males and females over the four periods. As can be seen, some volatility observes in RRR over the lowest 40^{th} percentiles for females. For males, on the other hand, such volatility only exists for the lowest 25 th percentiles. This perhaps is not surprising given that females are more likely to shift between full- and part-time jobs or moving in and out of employment for child care reasons. Note that across all four periods, females generally experience greater re-ranking as a fraction of the maximum possible compared to their males counterparts. The results also demonstrate that, over the shorter period, re-ranking is typically around 10 - 30% of the maximum mobility possible (conditional on an individual's position in the initial income distribution). As the period length is extended, this rate becomes closer to 50%.

Figure 7 demonstrates RRR^{pos}profiles for three different ethnic groups. This Figure suggests that re-ranking over a shorter period (e.g., 1 year) appears to be approximately linear across all h vlaues. This is more obvious for Māori ethnic group. From Figure 7, it is also apparent that the properties of re-ranking mobility across all three ethnic decompositions are similar in terms of the positional re-ranking mobility as the period considered is extended from 1 year to 15 years. However, the main difference between the three groups is that non-Māori and non-Pasifika groups experience the less amount of re-ranking mobility compared to the other two counterparts. The difference in re-ranking mobility decreases after 15 years.

Across-educational qualifications differences using RRR^{pos}, for the same periods, are shown in Figure 8. The Figure suggests that differences in re-ranking occured within the two ends of the spectrum, with no qualification and with University degree, appears to be similar across all h values. By 15 years, the two re-ranking curves for no qualification and university degree are almost indistinguishable for those above 70^{th} percentile. Note that the minimum of RRR^{pos}occurs at around the 20^{th} percentile in all four periods for the school- and post-school qualifications. This happends at around the 30^{th} percentile for without qualification and university degree cases. In general, a greater amount of re-ranking mobility is observed with the higher qualification attained.

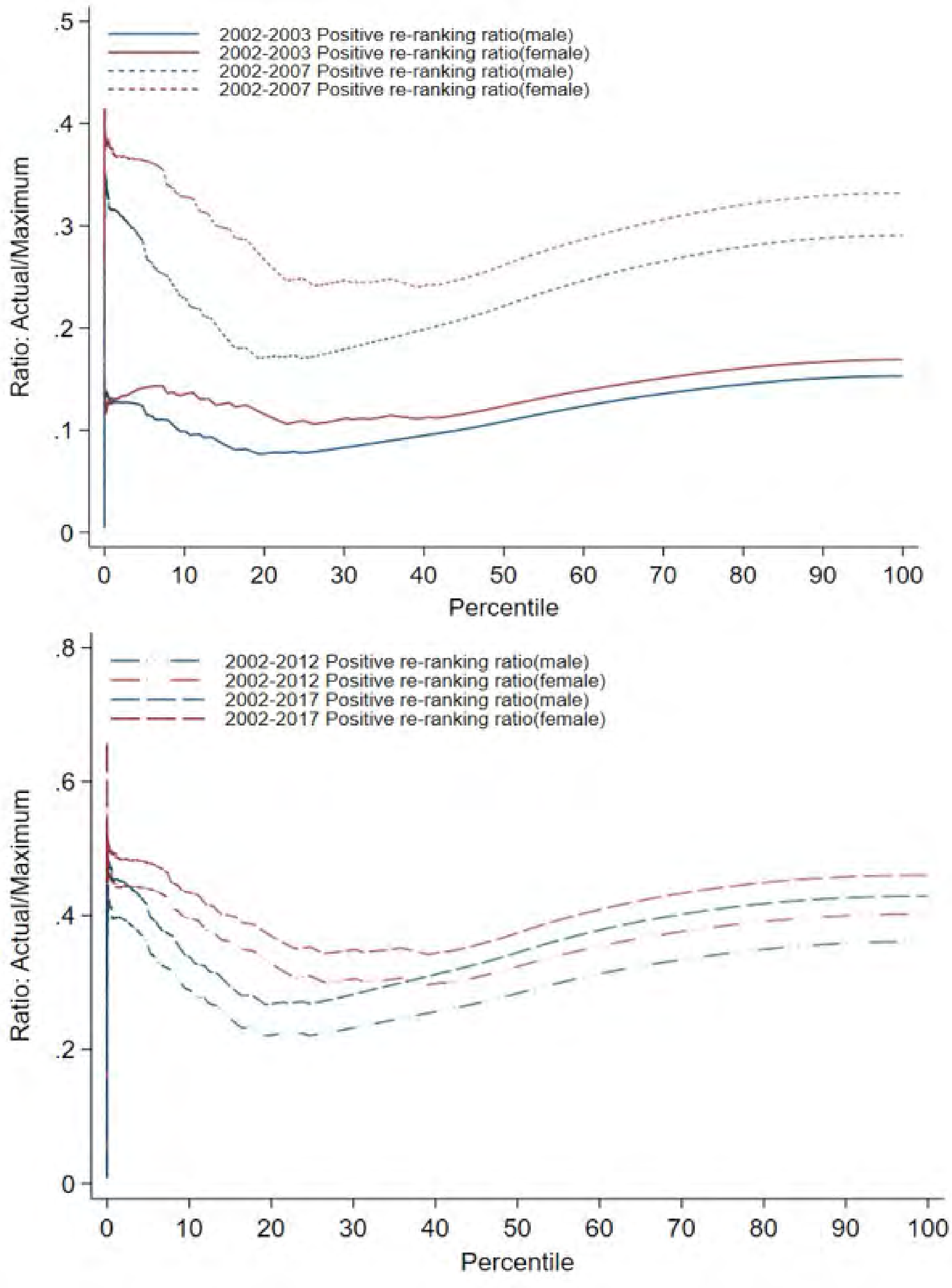

Figure 6: Comparing Positive Re-ranking Ratio Curves for Males and Females

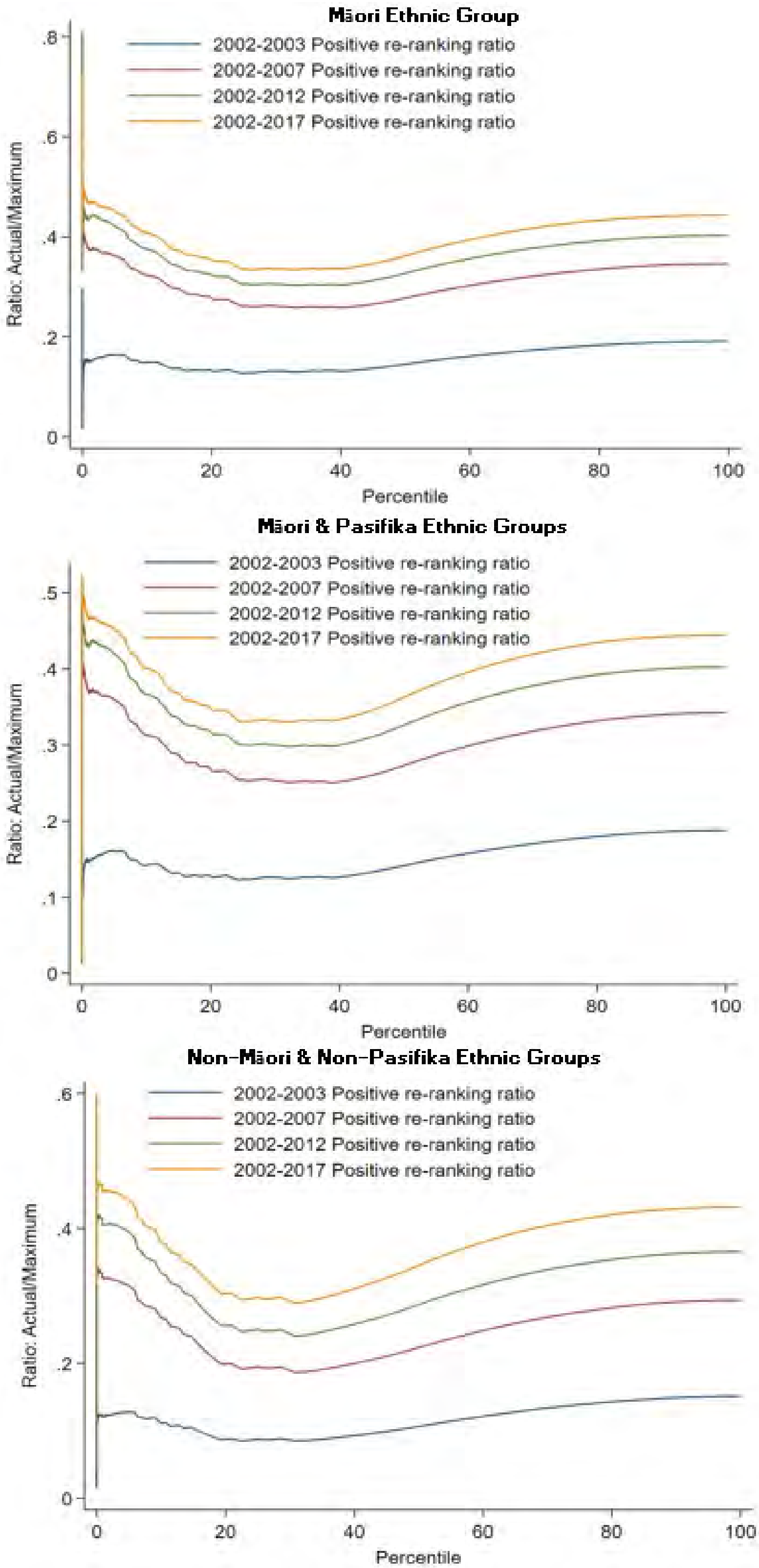

Figure 7: Comparing Positive Re-ranking Ratio Curves for Ethnic Groups

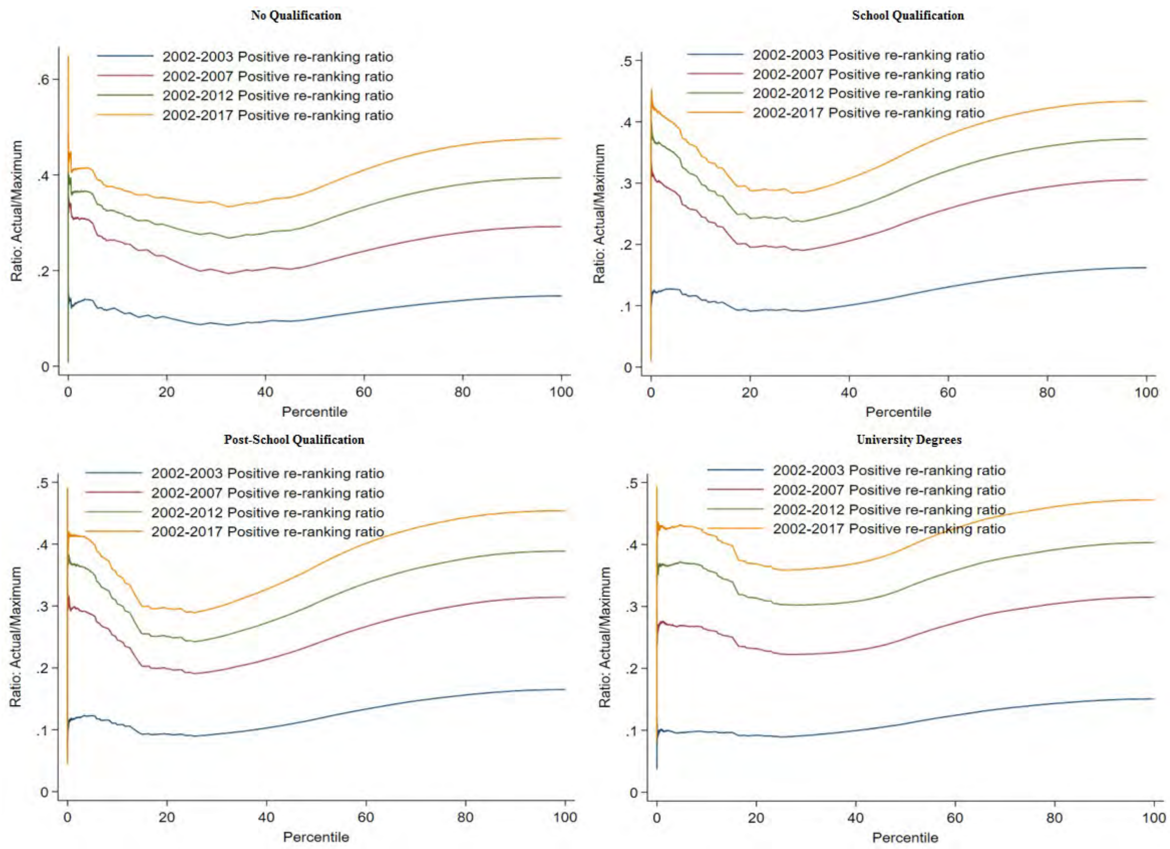

Figure 8: Comparing Positive Re-ranking Ratio Curves for Educational Qualifications

5 Conclusions

This paper has used a positional-change approaches to measure income mobility in New Zealand, using extensive administrative longitudinal data on the taxable incomes of New Zealand taxpayers over a number of periods ranging from 1 year to 15 years. Illustrations were presented based on panel data for 2002-03, 2002-07, 2002-12 and 2002-17.

After 15 years, evidence on the extent of re-ranking of individual incomes suggested a relatively high degree of positional mobility, compared to the maximum possible, especially among the lowest and highest income individuals. The evidence also suggested that some conclusions regarding the extent of re-ranking depends crucially on the re-ranking measure adopted – positive, net or absolute. For example, the highest re-ranking ratios are observed around the 40^{th} to the 70^{th} percentiles for an absolute re-ranking measure but rise steadily towards the 100^{th} percentile when only positive changes in rank are considered.

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About the Authors

Nazila Alinaghi is a Research Fellow in Public Finance at Wellington School of Business and Government, Victoria University of Wellington, New Zealand.
Email: nazila.alinaghi@vuw.ac.nz

John Creedy is Professor in Public Economics and Taxation at Wellington School of Business and Government, Victoria University of Wellington, New Zealand.
Email: john.creedy@vuw.ac.nz

Norman Gemmell is the Chair in Public Finance at Wellington School of Business and Government, Victoria University of Wellington, New Zealand.
Email: norman.gemmell@vuw.ac.nz