

NZDep2001 Index of Deprivation

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While the contents of this report have benefited considerably from the assistance of colleagues, the responsibility for this report remains solely with the authors.

Ethics and confidentiality

Ethical approval for the original NZDep91 project was obtained in May 1995 from the Central Regional Health Authority Wellington Ethics Committee.

Access to unrounded Census data was granted under a special contract with Statistics New Zealand. The access was granted in a strictly protected environment on Statistics New Zealand premises under supervision of Statistics New Zealand staff. The researchers were bound to preserve the confidentiality of individual respondent data by the same provisions of the Statistics Act 1975 that bind staff of Statistics New Zealand.

Executive Summary

NZDep2001 is an updated version of the NZDep91 and NZDep96 indexes of socioeconomic deprivation. NZDep2001 combines nine variables from the 2001 census which reflect eight dimensions of deprivation. NZDep2001 provides a deprivation score for each meshblock in New Zealand. Meshblocks are geographical units defined by Statistics New Zealand, containing a median of approximately 90 people in 2001.

The NZDep2001 index of deprivation has two forms—an ordinal scale and a continuous score.

- The NZDep2001 index of deprivation ordinal scale ranges from 1 to 10, where 1 represents the areas with the least deprived scores and 10 the areas with the most deprived scores.
- The NZDep2001 index of deprivation interval variable is the first principal component score, which has been scaled to have mean 1000 index points and standard deviation 100 index points. The NZDep2001 10 point scale is derived from this interval variable.

The NZDep2001 scale of deprivation from 1 to 10 divides New Zealand into tenths of the distribution of the first principal component scores. For example, a value of 10 indicates that the meshblock is in the most deprived 10 percent of areas in New Zealand, according to the NZDep2001 scores.

It should be noted that NZDep2001 deprivation scores apply to areas rather than individual people.

NZDep2001 combines the following census data (calculated as proportions for each small area):

| <i>Dimension of deprivation</i> | <i>Variable description (in order of decreasing weight)</i> |
|---------------------------------|--|
| Income | People aged 18-59 receiving a means tested benefit |
| Employment | People aged 18-59 unemployed |
| Income | People living in equivalised* households with income below an income threshold |
| Communication | People with no access to a telephone |
| Transport | People with no access to a car |
| Support | People aged <60 living in a single parent family |
| Qualifications | People aged 18-59 without any qualifications |
| Owned home | People not living in own home |
| Living space | People living in equivalised* households below a bedroom occupancy threshold |

*Equivalisation: methods used to control for household composition.

Introduction

This report describes the development of NZDep2001. The methods used in the creation of NZDep2001 are based on very similar methods used in the creation of NZDep91 and NZDep96, which are described in detail in *Research Report No.5 NZDep91 Index of Deprivation* (Crampton et al., 1997b), and *Research Report No.8 NZDep96 Index of Deprivation* (Salmond et al., 1998).

Minor changes only have been made to the methods used for NZDep2001. These changes are a result of changed income categories in the Census form, and of the use of a more precise definition of household crowding. A description and explanation of changes is given in the methods section. For convenience, unchanged methodological details have been extracted from *Research Report No.5* and *Research Report No.8* and placed in appendices to this report.

Work on NZDep2001 was largely carried out at the Statistics New Zealand Data Laboratory.

Further information regarding NZDep91 and NZDep96 may be obtained in the following three reports, one atlas, and two articles:

Crampton, P., Salmond, C. and Sutton, F. (1997), 'NZDep91: a new index of deprivation', *Social Policy Journal of New Zealand*, 9, 186-193.

Salmond, C., Crampton, P. and Sutton, F. (1998a), *NZDep96 Index of Deprivation Instruction Book*, Wellington, Health Services Research Centre.

Salmond, C., Crampton, P. and Sutton, F. (1998b), *NZDep96 Index of Deprivation Look Up Directory*, Wellington, Health Services Research Centre.

Crampton, P., Salmond, C., Kirkpatrick, R., Scarborough, R. and Skelly, C. (eds.) (2000), *Degrees of Deprivation in New Zealand: An atlas of socioeconomic difference*, David Bateman Ltd, Auckland.

Salmond, C. and Crampton, P. (2001), 'NZDep96 - What does it measure?', *Social Policy Journal of New Zealand*, 17, 82-100.

Salmond, C. and Crampton, P. (2002, in press), 'Heterogeneity of deprivation within very small areas', *Journal of Epidemiology and Community Health*.

Aim

The aim of the NZDep research programme is to develop small area indexes of socioeconomic deprivation for New Zealand.

Purpose of indexes

NZDep91, NZDep96 and NZDep2001 have been developed with three principal purposes in mind: resource allocation, research, and advocacy.

1. Indexes of deprivation have application in funding formulas. For example, indexes of deprivation are used in capitation funding formulas for primary health care services, the population-based funding formula for District Health Boards, and in funding formulas for social services in other sectors.
2. Indexes of deprivation have application in research in a variety of settings such as health and other social services. For example, in the health sector, many researchers use small area indexes to describe the relationship between socioeconomic deprivation and health outcomes; increasing levels of deprivation are associated with higher mortality rates, and higher rates of many diseases.
3. Indexes of deprivation are used by community groups and community based service providers to describe the populations they serve, and to advocate for extra resources for community based services.

Socioeconomic deprivation

Socioeconomic deprivation provides one approach to conceptualising and measuring the broader construct of socioeconomic position. The term socioeconomic position is being used here to mean "the social and economic factors that influence what position(s) individuals and groups hold within the structure of society" (Lynch & Kaplan, 2000, p.14). There are a number of theoretical and practical approaches to conceptualising and measuring socioeconomic position reflected in, for example, occupation-based and education-based socioeconomic measures.

Socioeconomic deprivation measures have been largely developed and used over the past three decades. While deprivation has to some extent underpinned conceptions of social class and socioeconomic status, area measures of deprivation represent a relatively new theoretical and practical approach to measuring the relative position of people in society (Townsend, 1990). Compared with the large body of literature relating to practical and theoretical aspects of occupation-based measures of socioeconomic position, knowledge about deprivation is still expanding rapidly, and the theory relating to deprivation continues to be refined.

Two highly influential theoretical traditions are identified with, respectively, Marx and Weber. The former tradition, following Marx, focuses on structural features of capitalist economies, while the latter, the Weberian approach, places more emphasis on individual characteristics and individual agency. The notion of socioeconomic deprivation may represent a move away from the Weberian emphasis on individual agency insofar as it marks a departure from measures of socioeconomic position based on hierarchies of individual occupation, income or education. Socioeconomic deprivation places greater emphasis on two other important aspects of social stratification: material resources and, to a lesser extent, structural features of society.

Socioeconomic deprivation reflects a 'neo-materialist' standpoint (that places emphasis on relative rather than absolute material conditions), taking the view that people have material, social, cultural and spiritual needs that are linked to the norms of their society and culture, and that it is possible to be deprived in one or more of these respects. Deprivation has been defined as a state of observable and demonstrable disadvantage relative to the local community or the wider society or nation to which an individual, family or group belongs (Townsend, 1987). A distinction is drawn between material and social deprivation, where material deprivation involves the material apparatus, goods, services, resources, amenities and physical environment and location of life (Townsend, 1987). Social deprivation involves the roles, relationships, functions, customs, rights and responsibilities of membership of society and its subgroups. While a primary distinction is made between material and social deprivation, sub-categories of both concepts have also been distinguished (Townsend, 1993, p.82). As a result, some people may be thought of as experiencing multiple deprivation, and others as experiencing only a single form of deprivation.

From a structural perspective individual characteristics such as education and income are determined by broader social factors that in turn provide the primary route for social policy interventions. The Weberian tradition has exerted a strong influence in the social sciences and epidemiology, expressed through the widespread use of individual characteristics such as occupation and income as measures of socioeconomic position. One of the effects of this emphasis on individual characteristics may be the implication that the solution to social inequalities is to be found in individuals' behaviour rather than in addressing—in Marxian terms—exploitative economic and social relations structurally embedded in society. This difference in emphasis is important insofar as structurally-mediated solutions to social inequalities are generally, and inherently, more radical than individually-mediated solutions that tend to focus on incremental alterations to the status quo. Area-based measures of deprivation, although mainly aggregates of individual characteristics, move towards reflecting structural elements related to area and community—that is, they are more likely to reflect aspects of the physical and social

infrastructure of communities than single variable individual measures such as income. However, area-based measures of deprivation clearly fall short of including the more fundamental structural features of society that determine social position, such as exploitive economic and social relations.

Lynch and Kaplan (2000) describe a hybrid Marxian-Weberian view that serves as a useful theoretical starting point for understanding the concept of socioeconomic deprivation.

The social and structural relations between groups in any particular society have a broadly defined material basis that is determined by productive relations to the economy. These relations are characterised by the effective control of resources and exercise of this control exploits, dominates, alienates, and excludes other less advantaged groups. (Lynch & Kaplan, 2000, p.20)

The above theoretical statement emphasises the material basis for defining and describing the social and structural relations between groups in society—it is this material basis that the concept of socioeconomic deprivation most clearly taps into. The statement then links this material basis with an individual's or group's relations to the means of production. That is, in Marxist terms, material resources are determined (in part at least) by one's access to the productive economy (via capital or labour).

Area measures of deprivation

Although studies of socioeconomic deprivation were commonplace in the nineteenth century, much of the modern scientific and statistical work on area measures of deprivation was not carried out until the 1970s and 1980s, for the purposes of research, planning and resource allocation (Liberatos et al., 1988; Townsend, 1993, p.85). A number of area-based measures of deprivation have been developed in the UK and the US (Carstairs, 1995; Krieger et al., 1997; Kunst & Mackenbach, 1995, p.42; Liberatos et al., 1988; Morris & Carstairs, 1991). Area-based indices have also been developed in

Australia and New Zealand (Castles, 1994; Crampton et al., 1997a; McLennan, 1990; Reinken et al., 1985).

Most area measures of deprivation have focused on measuring material deprivation, mainly on account of the existence of suitable variables in routine datasets. UK area measures of deprivation have generally not included direct measures of income, due to its non-availability in census datasets (Rose & O'Reilly, 1997, p.117). However, it is increasingly recognised that social aspects of deprivation are just as influential in relation to health status as material aspects of deprivation (Morris & Carstairs, 1991).

Variables included in various area measures of deprivation may be further classified into two groups: demographic and deprivation variables (Crampton et al., 1997b). Demographic variables such as age, sex and ethnicity are not directly amenable to change or influence, but may be associated with increased risk of deprivation. Deprivation variables are more direct markers of deprivation; for example income, housing occupancy and access to a telephone. A number of researchers have argued that demographic variables should be excluded from area measures of deprivation as they are not direct markers of deprivation (Carr-Hill & Chalmers-Dixon, 2002; Crampton et al., 1997b; Morris & Carstairs, 1991; Townsend, 1990). We have not included demographic variables in the NZDep index of deprivation.

The use of area measures of deprivation assumes associations between socioeconomic deprivation and outcome at various levels (individual, family, neighbourhood, etc) and allows different levels of association to be explored. For example, at the area level, deprived neighbourhoods may adversely affect health outcomes for individuals and, at the individual level, deprived individuals are more likely to suffer various poor health outcomes. An increasing number of studies are examining these multiple levels of association (see for example: Anderson (1997), Duncan (1999), Kleinschmidt (1995), Reijneveld (1998), Shouls (1996), Salmond (2001), and Sloggett (1994).)

Possible weaknesses of area measures of deprivation may include their complexity, vulnerability to selection of census variables, inconsistent statistical methods, measurement error when applied to individuals, ecological fallacy problems, spatial autocorrelation when used in ecological studies (Lorant et al., 2001), statistical limitations of small area aggregate data, and the long interval between censuses (Crampton & Laugesen, 1995). Possible weaknesses of particular relevance are described below.

First, whereas area measures of deprivation may be easy to understand (usually as ordinal scales such as lowest through to highest), the methods used to derive them can be complex. Similarly, the selection of variables for inclusion in area measures and the statistical techniques for their transformation vary considerably between different measures (Carr-Hill, 1988; Crampton & Laugesen, 1995; Morris & Carstairs, 1991), possibly leading to confusion regarding the choice of measure.

Second, measurement error inevitably occurs when area-based measures of socioeconomic position are applied to individuals—because not all people in deprived areas are deprived, and not all socioeconomically deprived people live in deprived areas (Blakely & Pearce, 2002; McLoone, 2001). For example, NZDep96 has been shown to be only weakly correlated with an individual deprivation index (Salmond & Crampton, 2001; Salmond & Crampton, in press, 2002). The effect of this measurement error generally will be to reduce the strength of observed associations between socioeconomic position and health outcomes. Researchers have found that the use of small spatial areas, such as meshblocks, diminishes the extent of measurement error (Crayford et al., 1995; Hyndman et al., 1995).

Third, concerns have been raised about the use of census data from small areas (Morphet, 1992). First, small denominators may lead to spurious high proportions. Second, random variation between small areas may limit the representativeness of small area data. Clearly, care must be taken in the interpretation of studies using small area measures of

deprivation; strength and consistency of associations is important in confirming the validity of results.

In summary, deprivation of area of residence is increasingly recognised as a salient predictor of life chances (Krieger, 1992; Krieger et al., 1997; Macintyre et al., 1993). Although there has been much debate concerning the choice of variables and their weighting, and the selection of statistical techniques, there is general agreement that area measures of deprivation provide powerful means of measuring variations in health status (Curtis, 1990; Gilthorpe, 1995; Gordon, 1995; Lynch & Kaplan, 2000, p.28; Morris & Carstairs, 1991; Reading et al., 1994; Townsend, 1993).

Cautions

A number of potential problems arise in using measures of socioeconomic position. The following are of particular importance for NZDep.

The indicator becomes the reality

The problem of confusing the indicator with the underlying phenomenon is discussed by Carr-Hill and Chalmers-Dixon (2002):

A common problem is to confuse the index with the phenomenon it purports to measure and, as a result, forget that *an index is only a proxy or partial measure*. (emphasis added)

This common problem is referred to as reification. It is crucial that users of any measure of socioeconomic position recognise this problem and scrutinise both the theoretical basis for, and the construction of, the specific index. Carr-Hill and Chalmers-Dixon (2002) give the following UK-based example:

The tendency is not unknown with measures of deprivation where it is more common to use phrases such as the ten most deprived local authorities, rather than "the authorities with the top ten scores on the DETR2000 index".

Users of NZDep indexes should refer to 'areas that have the most deprived NZDep scores' rather than 'the most deprived areas'.

Area versus individual measures

Please note that NZDep is a small-area measure of deprivation. Caution must be used if the index is applied to individuals. This issue is discussed in the above section on

socioeconomic deprivation, and in greater detail in *NZDep - What does it measure?* (Salmond & Crampton, 2001), and in *Heterogeneity of deprivation within very small areas* (Salmond & Crampton, in press, 2002).

Relative versus absolute deprivation

A view is sometimes expressed, in reference to NZDep, that 'it is disgraceful that still 10% of areas are most deprived'. Please note that 10% of areas will *always* fall into the most deprived decile of NZDep scores—NZDep is designed to measure *relative* socioeconomic deprivation, not *absolute* socioeconomic deprivation.

Apparent simplicity

The NZDep scales (from 1 to 10) have been constructed so that they can be readily used in a variety of contexts. They are easily presented graphically. This simplicity should not be allowed to obscure the underlying complexity of construction, the limitation of components available from the Census, and the underlying theoretical assumptions (discussed above in the section on socioeconomic deprivation).

Longitudinal comparisons

Difficulties arise in making comparisons between different NZDep indexes (ie, NZDep91, NZDep96, and NZDep2001). These difficulties are discussed in detail in Appendix five.

Constructing the index

Overview

Creation of a small area index of deprivation requires:

1. a source of data;
2. a definition for the small area;
3. choice of, and definitions for, the variables included in the index;
4. a method for using the variables to create the index; and
5. internal and external validation of the index.

The first four steps are discussed in turn below. Validation is discussed in *Research Reports No. 5* and *No. 8* (Crampton et al., 1997b; Salmond et al., 1998).

Data sources

NZDep2001 was created from data from the 2001 Census of Population and Dwellings. The variables included in NZDep2001 are all age and sex standardised proportions of people in a small area with an attribute.

Information was maximised by obtaining files from two sources:

- 1) all individual census forms of persons usually resident in New Zealand whose meshblock of usual residence can be ascribed, whether present in their usual residence on census night or not, (3.74 million); and

- 2) dwelling forms from private dwellings (3.60 million records); that is one record for each person usually resident in a private dwelling.

More details concerning the source populations are given in Appendix one.

Defining small areas

The NZDep small areas used to create the base index of deprivation are unique to the deprivation project (NZDep2001 small areas). The building blocks for these small areas are standard Statistics New Zealand meshblocks. Where necessary, meshblocks have been agglomerated to create NZDep2001 small areas with a population of at least 100 persons usually resident, where possible. Agglomeration occurred only within primary sampling unit (PSU) boundaries so that the resulting small areas were geographically connected. (PSUs are areas used internally by Statistics New Zealand for their labour force and other surveys.) It should be noted that connectivity does not necessarily imply consecutively numbered meshblocks. In general, the NZDep2001 small areas consist of one or two meshblocks. Details of the agglomeration are included in Appendix five (Comparing areas over time, section 2a).

In addition to the desire to have at least 100 persons in each NZDep2001 small area, it was important to check that individual proportions in an area did not have very small denominators because of small numbers of individuals in particular age groups, perhaps compounded by missing data. We therefore identified those NZDep2001 small areas with any proportion denominator less than 20. These proportions occurred in 110 small areas. The agglomeration steps were therefore repeated, further agglomerating these 110 small areas up to their respective primary sampling unit boundaries (where possible). This yielded 49 small areas instead of the initial 110 small areas which were then re-checked for denominators less than 20. Ultimately 13 NZDep2001 small areas involving 17 meshblocks have been withheld from the index because two or more of the nine

denominators were less than 20 and the index value was considered unreliable. The final number of NZDep2001 small areas was 22,077.

The following meshblocks have had their deprivation values withheld:

0788102, 0364601, 0496102, 0999101, 0999102, 0974500, 1239300, 1166900, 1869401, 1869402, 1869800, 1875102, 2003505, 2343701, 2851001, 2949900, 3138800

Choice of variables for inclusion in NZDep2001

The NZDep2001 index of deprivation reflects eight dimensions of material and social deprivation. These dimensions reflect lacks of income, employment, communication, transport, support, qualifications, owned home and living space. A list of the variables used in NZDep2001 is given in Table 1.

Table 1: Variables included in NZDep2001

| <i>Variable (proportions in small areas) in order of decreasing weight in the index</i> |
|---|
| People aged 18-59 receiving a means tested benefit |
| People aged 18-59 unemployed |
| People living in equivalised* households with income below an income threshold |
| People with no access to a telephone |
| People with no access to a car |
| People aged <60 living in a single parent family |
| People aged 18-59 without any qualifications |
| People not living in own home |
| People living in equivalised* households below a bedroom occupancy threshold |

*Equivalisation: methods used to control for household composition.

Three variables used in NZDep2001 have been slightly modified, either as a result of changed definitions or categories in the Census (means tested benefit status, household NZDep2001 Index of Deprivation (August 2002)

income), or as a result of an updated definition (occupancy). A description of these changes is given below. For convenience, a short description of the unchanged variables (access to a telephone, access to a car, unemployment, single parent family, no qualifications, and dwellings not owner occupied) has been extracted from *Research Report No. 5* and placed in Appendix two.

Means tested benefit status

This variable is obtained for those people aged 18 to 59. The means tested benefits included in the definition of this variable changed as a result of changes to the question in the 2001 census. Means tested benefits included in the NZDep2001 version of this variable are: Community Wage - sickness benefit; Domestic Purposes Benefit; Invalid's Benefit; and Other government benefits, government income support payments, or war pensions.

Most, but not all, government benefits are income tested to some extent (personal communication, Ministry of Social Development, March 2002). Family Support is not listed in the 2001 Census because it is a tax benefit rather than a cash payment. The 'New Zealand Superannuation or Veterans Pension' category is not included in this variable because New Zealand Superannuation is not income tested (apart for the relatively small number of people on Superannuation who have an 'underage' spouse), it does not reflect standard of living in the way the other means tested benefits do, and its strong correlation with age would influence results unduly. Only about 7000 people are on Veterans Pensions.

The proportion of people on the 'Community Wage - job seeker' (unemployment benefit) is not used, even though it is an income tested benefit, because unemployment is picked up in the unemployment variable.

Student Allowance is income tested, but is not included in the means tested benefit variable because it was considered that the majority of people on this benefit were

probably not disadvantaged or socioeconomically deprived in the same way as those on the other means tested benefits.

The 'War pensions' component of 'Other government benefits, government income support payments, or war pensions' category is not income tested and applies to 23,000 people.

Household income

The poverty line work of Stephens and Waldegrave (2001) was used as a guide to setting the household equivalised income threshold.

Using a poverty line of <60% of median equivalised disposable household income, before adjusting for housing costs, 15.4% of households are in poverty, which equates to 14.7% of the population. Table 2 gives an abbreviated distribution of equivalised income showing where the 2001 threshold was set.

Table 2: Jensen equivalised household income (abbreviated)

| Equivalised-income* | Cumulative percent of people | |
|---------------------|---------------------------------|----------------|
| under 11,191 | 5.00 | } Deprived |
| .. to 14,062 | 9.00 | |
| .. to 14,939 | 10.00 | |
| .. to 16,017 | 11.00 | |
| .. to 17,233 | 11.96 | |
| 17,236 | 14.37 | |
| 17,239 | 14.38 | |
| .. to 17,683 | 14.99 | |
| 17,699 | 15.00 | |
| <hr/> | | |
| .. to 18,677 | 16.00 | } Not deprived |
| .. to 19,670 | 19.97 | |
| 19,676 | 20.01 | |
| .. to 23,121 | 24.97 | |
| 23,127 | 25.01 | |
| etc | etc | |

* Note that because the source information is in income bands, there are only a limited number of values for 'equivalised' income.

Occupancy

Occupancy describes the relationship between housing space available and persons usually resident in the house. For deprivation purposes, the extreme of an occupancy scale is used. It is usually called overcrowding.

NZDep91 and NZDep96 used a crowding definition consistent with an OECD standard formula for occupancy. The crowding threshold used was: any household with greater than one person-equivalent per bedroom. A person-equivalent was defined following

Morrison (1994): children aged 10 and over are equivalent to one adult; children aged under 10 are equivalent to half an adult.

For NZDep2001 the Canadian National Occupancy Standard formula for calculating occupancy was used. This formula was considered to be a more precise way of capturing occupancy than the previously used OECD formula. The Canadian National Occupancy Standard sets the bedroom requirements of a household according to the following composition criteria (Statistics New Zealand, 1998, p.79):

- There should be no more than two people per bedroom;
- Parents or couples share a bedroom;
- Children under five years, either of the same or the opposite sex, may reasonably share a bedroom;
- Children under 18 years of the same sex may reasonably share a bedroom;
- A child aged five to 17 years should not share a bedroom with one under five of the opposite sex;
- Single adults 18 years and over and any unpaired children require a separate bedroom.

The data for 2001 are shown in Table 3.

Table 3: Crowding index (number of bedrooms over or under those required by the Canadian National Occupancy Standard)

| <i>'Spare' bedrooms</i> | <i>Percent (people)</i> | <i>Cumulative Percent</i> | |
|-------------------------|-----------------------------|---------------------------|----------------|
| -12 to -3 | 1.12 | 1.12 | } Deprived |
| -2 | 2.04 | 3.16 | |
| -1 | 6.94 | 10.09 | |
| 2001 cut-off | | | |
| 0 | 26.03 | 36.12 | } Not deprived |
| + 1 | 34.33 | 70.45 | |
| + 2 | 22.66 | 93.12 | |
| +3 to +13 | 6.88 | 100.00 | |

Possible new candidate variables available in the 2001 census

The 2001 Census was examined in detail for possible new candidate variables for NZDep2001. To be considered for inclusion in the index, variables needed to be consistent with the theoretical approach adopted for NZDep (see Crampton (1997b)). Only one potential variable was identified—home heating.

Question 15 of the 2001 dwelling form relates to home heating. The response "never use any form of heating in this dwelling" was explored as a possible deprivation variable.

Household heating data for 1996 were obtained from Supermap 3—number of houses with no form of heating by Territorial Authority (TA). Proportions were calculated using total dwellings as the denominator. There was a strong North-South gradient in the resulting proportions at TA level, with far fewer households in the South not using any form of heating.

It was decided that 'no home heating' could not be used in NZDep because the North-South gradient would build a structural element into the definition of deprivation (that is,

people living in dwellings in the North would be, by definition, more likely to be deprived by virtue of the warmer climate).

Creating the index

Principal components analysis was used, as previously, to create the index. Principal components analysis is a multivariate method which identifies linear combinations of variables which progressively account for the overall variation in the data. The first principal component accounts for the most variation, the second accounts for as much of the remaining variation as possible, and so on. Further information is contained in *Research Report Number 5* (Crampton et al., 1997b).

NZDep2001 is the first principal component of nine variables. Each variable is a proportion of persons in a small area. The index was created, as before, using standardised proportions, where each small area proportion was standardised in eight age/sex groups (0-17, 18-39, 40-59, 60 and over, for each sex) to the New Zealand population structure. Proportions were calculated both standardised and unstandardised as a way of checking the effect of standardisation. A description of the standardisation process used in creating NZDep2001 is given in Appendix three.

Technical difficulties encountered occasionally when an NZDep2001 small area had no one in certain age/sex groups were overcome, as before, by *defining* such proportions to be zero. The explanation given in *Research Report No. 5* is repeated in Appendix four (Structural zeros). Other technical difficulties involving 'not specified' codes were treated as before and are also described in Appendix four (Not specified).

Results

Defining small areas

Meshblocks varied in size from zero to more than 300 persons usually resident. Small meshblocks were agglomerated within primary sampling units to form NZDep2001 small areas with, as far as possible, at least 100 persons usually resident (Table 4). Primary sampling units are used internally by Statistics New Zealand for non-census sampling purposes.

Table 4: Distribution of population in NZDep2001 agglomerated small areas

| <i>Usually resident population*</i> | <i>Number of NZDep2001 small areas</i> | <i>Cumulative percent</i> |
|-------------------------------------|--|---------------------------|
| 31 - 60 | 28 | 0.1 |
| 61 - 75 | 126 | 0.7 |
| 76 - 90 | 470 | 2.8 |
| 91 - 99 | 548 | 5.3 |
| 100 - 120 | 3467 | 21.0 |
| 121 - 150 | 5542 | 46.1 |
| 151 - 200 | 6746 | 76.7 |
| 201 - 300 | 4298 | 96.1 |
| Over 300 | 852 | 100.0 |

* The target size for NZDep2001 small areas was a minimum of 100 persons usually resident, where possible. Populations above are randomly rounded to base 3. A small number of people usually resident are not accounted for in NZDep2001 because they live in off shore islands, inlets, etc.

The distribution of the number of meshblocks incorporated in each NZDep2001 small area is shown in Table 5.

Table 5: Number of meshblocks per NZDep2001 small area

| <i>Number of meshblocks</i> | <i>Proportion of small areas (%)</i> |
|-----------------------------|--------------------------------------|
| 1 | 59.2 |
| 2 | 26.7 |
| 3 | 7.4 |
| 4 | 3.2 |
| 5 | 1.6 |
| 6 or more | 2.0 |
| total (N = 22,077) | 100.1 |

NZDep2001 scores and NZDep2001 scale

We used principal components analysis to create the index from the nine variables listed in Table 1. The first principal component explained 57.7% of the overall variance (very close to the NZDep96 figure, 57.4%). The weights for each of the nine variables in the first principal component are shown in Table 6. The first principal component yields the NZDep2001 score.

Table 6: Weights on first principal component

| <i>Proportion of persons (with a lack of something)</i> | <i>Weight on first principal component</i> |
|--|--|
| People aged 18-59 receiving a means tested benefit | 0.361 |
| People aged 18-59 unemployed | 0.353 |
| People living in households with equivalised* income below an income threshold | 0.350 |
| People with no access to a telephone | 0.336 |
| People with no access to a car | 0.332 |
| People aged <60 living in a single parent family | 0.325 |
| People aged 18-59 without any qualifications | 0.319 |
| People not living in own home | 0.312 |
| People living in households below equivalised* bedroom occupancy threshold | 0.309 |

* Equivalisation: methods used to control for household composition.

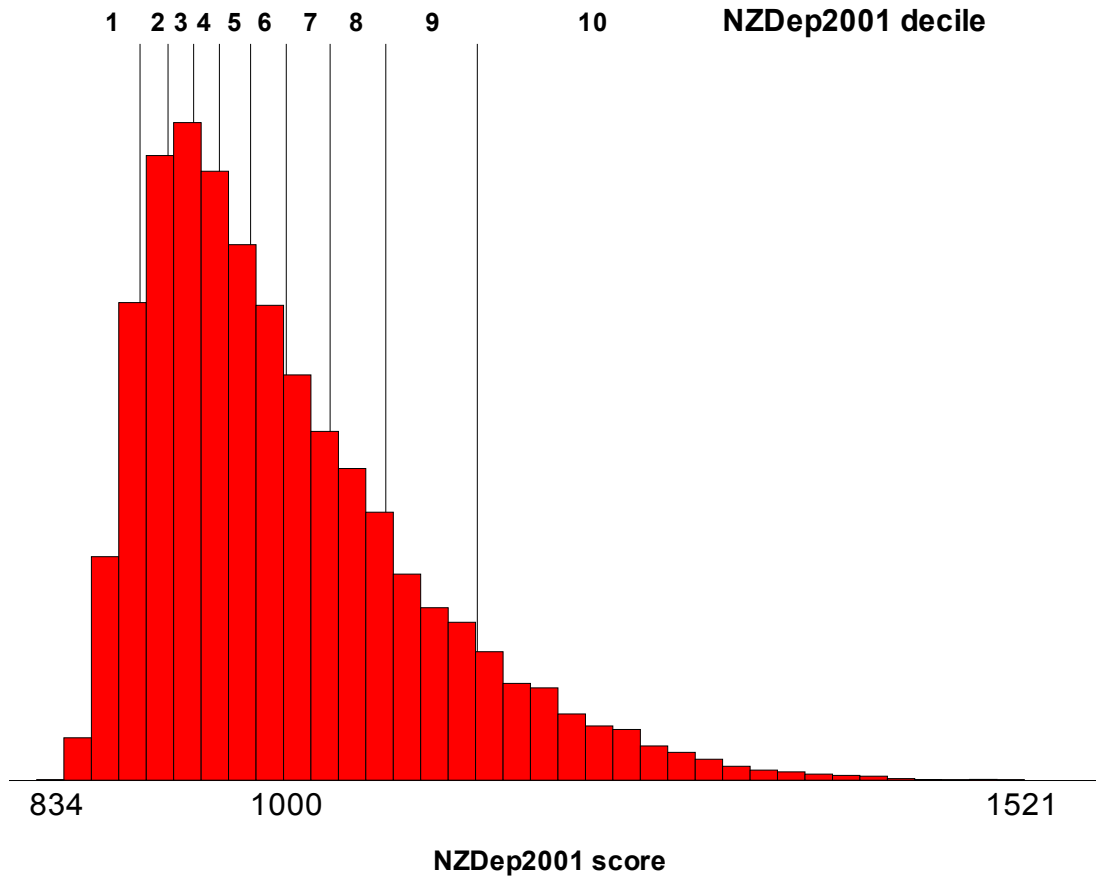
A number of meshblocks, mainly sea or estuary, have been omitted from the index, in total containing very few people. Deprivation values have been withheld for a further 17 meshblocks because more than one of the nine proportions within a small area have denominators less than 20. These 17 meshblocks could not be agglomerated with any other small area within a PSU. The 17 meshblocks are listed in *Constructing the index, Defining small areas*.

An NZDep2001 scale of deprivation has also been produced. This scale from 1 to 10 divides New Zealand into tenths of the distribution of the first principal component scores, where, for example, a value of 10 indicates that the area is in the most deprived 10% of NZDep2001 small areas in New Zealand.

Figure 1 shows the relationship between the NZDep2001 scores and the NZDep2001 scale from 1 to 10. The skewed distribution illustrates clearly that NZDep2001 reflects a continuum from 'least deprivation' to 'most deprivation', rather than from 'affluence' to deprivation'. This was intended, as all the variables in NZDep2001 reflect a lack of something.

Note that the decile cut-points of the NZDep2001 scale are not equally spaced, so that, for example, the difference between deciles 2 and 5 is not huge, unlike the difference between deciles 7 and 10. Other scales can be created from the NZDep2001 scores. For example, fortieths have been used to explore national five-year mortality rates, and quartiles have been used to explore National Health Survey data. The choice of division for the scale should be made bearing in mind the skewed nature of the distribution of the underlying NZDep2001 scores. Divisions based on unequal sub-sample sizes should be used with caution, as the precision of any resulting statistics will vary by division category.

Figure 1: Distribution of NZDep2001 scores, with the NZDep2001 decile scale superimposed



Standardisation

Standardisation of the input variables made a small but appreciable difference to the overall performance of the index. An illustration of the difference is provided for NZDep96 in *Research Report No 8* (Salmond et al., 1998). Further details about the standardisation procedure are contained in Appendix three.

Glossary of terms and abbreviations

- Agglomeration** Combining areas which are geographically connected.
- CAU** Census area units are administrative areas defined by Statistics New Zealand.
- Deprivation** Deprivation is a state of observable and demonstrable disadvantage relative to the local community or the wider society or nation to which an individual, family or group belongs (Townsend, 1987).
- Townsend (1987) distinguishes between material and social deprivation. Material refers to material apparatus, goods, services, resources, amenities and physical environment and location of life. Social refers to the roles, relationships, functions, customs, rights and responsibilities of membership of society and its subgroups.
- Meshblock** Meshblocks are the smallest administrative areas used by Statistics New Zealand. Meshblocks had a median population of approximately 90 persons in 2001.
- NZDep2001 scale** A ten category ordinal scale from 1 (assigned to the 10% of NZDep2001 small areas with the least deprived NZDep2001 scores) to 10 (assigned to the 10% of NZDep2001 small areas with the most deprived NZDep2001 scores). (Note the wording to avoid 'reification'—see *Cautions, The indicator becomes the reality.*)

| | |
|--------------------------------------|--|
| NZDep2001 score | The value for a small area is the score for the area on the first principal component. The distribution has mean 1000 and standard deviation 100. The distribution is skewed. |
| Principal components analysis | Principal components analysis is a method of multivariate analysis that is used to find a few combinations of variables, called components, that adequately explain the overall observed variation, and thus reduce the complexity of the data (Kirkwood, 1988). |
| PSU | Primary sampling units are small areas defined by Statistics New Zealand to be approximately 60 households. |
| SNZ | Statistics New Zealand |
| Socioeconomic position | Socioeconomic position is a descriptive term for a person's position in society, which may be expressed on an ordinal scale using criteria such as income, educational level obtained, occupation, value of dwelling place, deprivation of area of residence, etc. |
| TA | Territorial Authorities are larger administrative areas defined by Statistics New Zealand. |

Appendix one: Source populations

Data for NZDep are extracted from either individual forms or dwelling forms of the Census.

Individual form data

Eligible people are those usually resident in New Zealand, even if they are temporarily absent from their usual residence, but are elsewhere in New Zealand. Such 'visitors' will have on their individual forms two meshblock identifiers, 1) meshblock of residence on census night, and 2) meshblock of usual residence. Using the meshblock of usual residence as the identifier ensures that the entire usually resident population of New Zealand is included in the calculation of the following three variables: qualifications, unemployment, and income support.

Dwelling form data

Eligible people are all those living in private dwellings. This excludes people permanently or temporarily living in hospitals, nursing homes, prisons, retirement homes, welfare education or relief institutions, defence establishments, hotels, motels, guest houses, boarding houses, motor camps, construction camps, youth camps, staff quarters (eg nursing home, seasonal fruit pickers), vessels (except the navy), communes, marae, and others. Data for people living in non-private dwellings are not necessarily relevant; for example, housing tenure and occupancy are not salient characteristics for people in retirement homes. Also excluded are visitors to private dwellings.

In 2001 there were 8364 non-private dwellings. Their residents account for the difference between denominators based on the usually resident population from the Census and denominators based on NZDep developmental source files.

The six dwelling form variables are: household income, crowding, telephone, vehicle, tenure and family type. The denominators for the proportions using these variables are all those people living in private dwellings.

Why do we use two different source populations?

The rationale for choosing the source populations was to maximise the amount of information incorporated into NZDep. Another option would have been to develop the entire index from the usually resident population in private dwellings. This approach would have omitted information from individual forms from people living in non-private dwellings.

The denominator for rate calculations using NZDep could appropriately be the usually resident population, or the usually resident population in private dwellings. We recommend the former; in practice there will be very little difference.

Appendix two: Description of variables used in NZDep

Nine deprivation-related variables have been used to create NZDep2001. Three have already been described under *Constructing the index* (means tested benefit status, household income, and occupancy). The other six variables are described below.

1. Access to telephone

This question was included for the first time in the 1996 Census of Population and Dwellings. The access to telephone variable is consistent with the theory of deprivation, and was included in the principal components analysis, and subsequently in NZDep96 and NZDep2001. The definition of the variable is the proportion of people without access to a telephone in their dwelling (private dwellings only).

2. Unemployed

The unemployed variable refers only to the 18 to 59 year age group.

3. Single parent families

The following are abbreviated versions of Statistics New Zealand definitions:

- a family consists of a couple (legal or defacto marriage) with or without children, or one parent with children (ie, a brother and a sister is not a family);
- a household is a group of people who live together whether related or not; and,
- a dwelling is the physical structure occupied by a household.

If a three generation family lives in a dwelling, Statistics New Zealand creates two families, *but each person is only counted once*.

Therefore:

- there may be more than one family per household (and therefore per dwelling); and,
- the sum of occupants of households equals the sum of all people in families and all people not in families.

Our definition of the *proportion of single parent families* variable is: *people less than 60 in a single parent family with dependent children as a proportion of all people under 60.*

The denominator includes everyone aged under 60 years (ie, those considered to be at risk of being in a single parent family). This variable is restricted to those aged under 60 years in order to avoid inflation of the denominator by large numbers of elderly people who are less likely to be in a single parent family.

4. No qualifications

The no qualifications variable refers only to the 18 to 59 year age group. No qualification indicates that no qualification has been obtained from a completed course of at least three months of full time study.

5. Dwellings not owner occupied

The housing tenure variable is: proportion of people in dwellings not owner occupied. Two categories of 'dwelling not owned by usual resident(s)' were used to capture not owner occupied. The third category, 'dwelling not owned by usual resident, who do not make rent payments', was treated as not specified since it was not possible to determine whether this represents an advantage or a disadvantage (for example, both a farm labourer and a multinational company executive could have accommodation provided rent free). (If this third category is included in the deprivation index the weight on the

first principal component changes from 0.312 to 0.304—that is, excluding the third category makes the 'not owner occupied' variable more clearly a deprivation variable.)

6. Access to car

This variable measures the proportion of people (children and adults) with no access to a car. Access to transport (cars) has relevance to children as well as adults.

Appendix three: Standardisation

Age and sex

All variables are related to age and sex to some extent. Therefore it was important to standardise for both age and sex, and compare the standardised indexes with non-age/sex standardised indexes. The resulting comparisons allowed investigation of the effect of age/sex standardisation on the ranking of small areas.

The options available for controlling for age and sex confounding were: age/sex standardisation; stratification; and, restriction. Age/sex standardisation was used with each variable.

Age/sex standardisation in five year age bands was not possible because of the problem of small numbers (small areas of about 100-200 people will not allow full age/sex standardisation). Therefore indirect standardisation was carried out using four age bands: 0-17; 18-39; 40-59; 60+. The youngest age group, 0-17, reflects non-voting status and, in general, dependency. The oldest age group, 60 and over, reflects 1991 entitlement to state retirement income, and vulnerability to changing living arrangements, income levels, employment status, and health status. (1991 was the first time for which an index of deprivation was created from Census data.) The remaining adults have been split into two groups of roughly equal size: 18-39 and 40-59.

Indirect standardisation

The purpose of standardisation is to remove the effects of age and sex, as far as possible, from our deprivation variables within each small area. Indirect standardisation of proportions was used, with the New Zealand population as the standard population.

Indirect standardisation for age and sex was chosen due to the small denominators in each small area observation (see Borman (1992) for further discussion of indirect standardisation).

The following formula was used as the basis for indirect standardisation of the variables.

$$\text{Standardised ratio} = \frac{\sum_{i=1}^8 n_i}{\sum_{i=1}^8 p_i R_i}$$

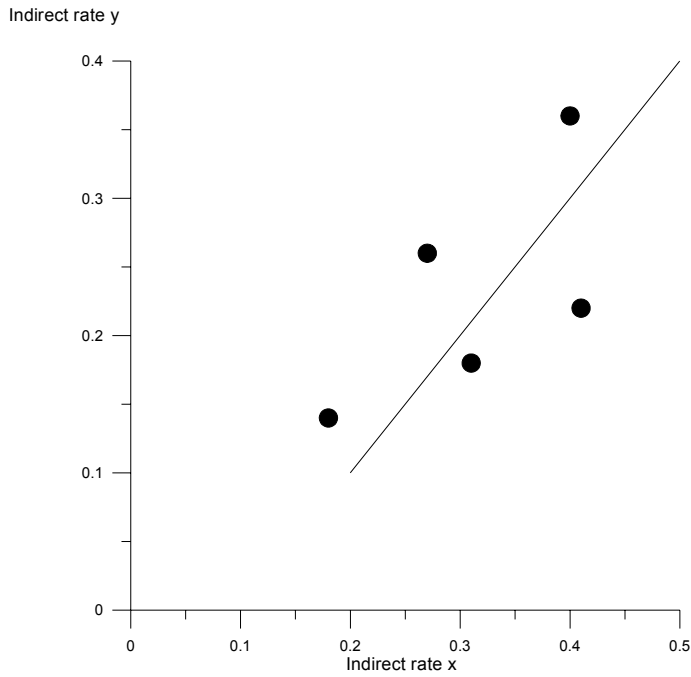
Where: the subscript i refers to the age/sex member of the array
 n is the number of people in the small area with the desired characteristic
 p is the population 'at risk' in the small area
 R is the rate of the characteristic in the standard (New Zealand) population

The result of the above calculation was multiplied by the overall New Zealand rate to create an age/sex adjusted proportion.

Non-responses were those records in which the value was recorded as 'not-specified'. The number of 'not-specifieds' was removed from the p and R denominators (and was automatically not included in the numerators). Thus the population at risk in any age/sex category (p_i) was the sum of those with, and those without, the characteristic.

Standardised ratios (or indirectly standardised rates) "can only be compared to the median of the distribution from which they are derived and not between two distributions" (Inskip et al., 1983). That is, we should not compare one standardised rate with another, but only each with 100. In the development of the index we do not compare one standardised rate with another in a different small area; we correlate pairs of indirect rates. If we plot the pairs of indirect rates on a graph, each point relates one indirect rate (X) to the other indirect rate (Y) *for the same small area*. These *points* are then essentially compared for

their positions relative to a straight line, which would indicate perfect correlation (as shown in the figure).



Overall 11.1% of small areas changed their decile rank by ± 1 when comparing indirectly standardised and raw deciles, with a further two small areas changing by 2, and one small area changing by 3.

Ethnicity

Ideally proportions should have been standardised by ethnicity (European, Maori, Pacific Island, other) as well as by age and sex. However, small numbers per ethnic group in NZDep small areas preclude standardising for this variable on top of age and sex. This is of no concern in funding formula applications which treat ethnicity explicitly along with age and sex.

Appendix four: Methodological issues

Equivalisation

Equivalence scales are “measures of the relative incomes needed by different types of families to attain the same material standard of living” (Whiteford, 1983). Equivalised household income was used for calculating the income variable so that, for example, the standard of living of a household consisting of a single person with an income of \$40,000 could be compared to that of a household consisting of two adults and six children on an income of \$40,000.

The revised Jensen scale was chosen for use in the equivalised measures of income (Jensen, 1978; Jensen, 1988). A two adult family is used (arbitrarily) as the 'reference household' (expenditure = 1.0), and figures are given for different family configurations (up to six children). Hence, for example, to obtain an equivalent standard of living as a two adult family, a family comprised of two adults and two children would require 1.41 times the income of the two adult family.

Structural zeros

The research considered the implications of meshblocks with no one in certain age/sex groups.

Taking a meshblock with no one over 60 in it as an example then proportions of those over 60 with certain characteristics are mathematically not defined. In a SAS programme the proportion would be given a missing value. This, in turn, means that no principal component score could be calculated for this meshblock.

Conceptually, if there is no one in a meshblock over 60 then the *meshblock* is not deprived from the point of view of, say, elderly people with no access to a telephone in their dwelling. Thus the proportion in the meshblock deprived in this way was *defined* to be zero. This allowed the meshblock to be allocated a meaningful principal component score.

Not specified

'Not specified' refers to census questions for which there was no response. Values for 'not specified' were not included in denominators for the input variables for the principal components analysis.

A simple modelling exercise carried out for the 1991 Census dataset indicated that there would be little to choose between including the 'not-specified' and excluding them. The bias when 'not-specified' are included is always negative, whereas the sign of the bias can vary when the 'not-specified' are left out.

Appendix five: Longitudinal analyses

Introduction

The NZDep2001 index of deprivation is the third census-based index to be produced. (The earlier ones were NZDep91 and NZDep96.) The first two were created one year apart in calendar time, and NZDep96 was improved in two ways. First, we dropped two variables for theoretical reasons. Second we were able to include another deprivation variable into NZDep96 from a new question in the 1996 Census relating to whether people had access to a telephone or not. These changes—from ten variables in the 1991 version to nine variables in the 1996 version, eight of which were common to both indexes—meant that these indexes should be compared only with caution. There are, in addition, technical reasons to be cautious (see below).

There are fewer obvious differences between the 1996 and 2001 versions of NZDep and we are aware that many researchers would like to use the index to inform longitudinal studies. We can distinguish two types of longitudinal study—those comparing areas over time, and those looking for changes in the relationship between deprivation and some other variable (eg mortality) over time.

Our conclusions are that:

1. **AREA COMPARISONS at the meshblock level, over time, should not be attempted. Comparisons at a higher aggregation, such as Territorial Authorities, or perhaps Area Units, may be less fraught, but we would still urge great caution in the interpretation of changes from one area to another.** The following discussion in *Comparing areas over time* should lead the reader to be very wary.

2. **Comparing RELATIONSHIPS between deprivation and another variable, over time, may be less fraught, but we would still urge caution.** See *Comparing relationships with deprivation over time* below.

Note that each NZDep index of relative deprivation (NZDep91, NZDep96, NZDep2001) divides the country into 10, where the highest value indicates the 10% of NZDep2001 small areas with the most deprived NZDep2001 scores. It is important to remember that *by definition 10% of small areas will always fall into the most deprived group*—irrespective of the absolute deprivation in those areas or the overall wealth of the country.

Comparing areas over time

Meshblocks can change deprivation values between any two censuses for both substantive and technical reasons:

1. Substantive reasons

- a) The local neighbourhood has changed in population size and/or characteristics through housing development—such as new subdivisions, or inner-city apartments created in disused office or warehouse space, or housing demolition.
- b) The local neighbourhood has changed in characteristics through changes in house ownership.

These changes may give rise to either or both of two consequences:

- a) The usually resident population size in the meshblock changes somewhat and the meshblock boundary remains unchanged; and/or
- b) The usually resident population size increases substantially and Statistics New Zealand splits the original meshblock into two (or more) new meshblocks. In this case the original seven-digit meshblock number is discontinued and new ones are created with the same first five digits. Thus the original meshblock number would end with the two digits '00'. If necessary, it is then split into (say) two meshblocks with the same first five digits and the endings '01' and '02', while the '00' number is discontinued. If, later, the '02' meshblock needs to be split, the '02' number is discontinued and (if it is again split in two) the numbers '03' and '04' are used.

These substantive changes can thus give rise to new meshblocks that are not readily comparable to old ones as well as to meshblocks that have 'legitimately' changed NZDep values through population movement.

2. Technical reasons

- a) Small area definitions are not always identical from one Census to the next.

Small areas are defined on the basis of the current usually resident population count, where meshblocks with usually resident populations under 100 are agglomerated (pooled) within Statistics New Zealand's internal Primary Sampling Unit (PSU) boundaries, if this is possible. PSUs usually contain one or two meshblocks, but may contain more (often with very small population counts).

Our agglomeration algorithm creates small areas by pooling small meshblocks, if necessary, as they increase in population count, until the pooled group contains at least 100 people, if that is possible. On a second pass, working from smallest to largest small area, any remaining too-small areas are agglomerated with the next smallest area(s), again if this is possible within the PSU boundary. The resulting census-time-specific small areas thus have the least number of constituent meshblocks consistent with the dual requirements of at least 100 people usually resident and boundaries within a single PSU. The result is over 20,000 small areas constructed from over 35,000 meshblocks.

Thus the agglomeration procedure applied to different censuses inevitably changes the composition of some of the small areas as a result of changes in the size of the New Zealand population and changes in the occupiers of individual homes.

The NZDep index is created from proportions created for each small area. Changed small area boundaries may give rise to somewhat different constituent populations from which proportions are derived. This may result in changes in the final NZDep value for the constituent meshblocks for the small area (which are each given the small area NZDep value). Such a change, therefore, may have

more to do with the boundary changes for the small area than any changed circumstances among the residents.

- b) NZDep distributions are not identical from one census to the next.

The base NZDep values are the scores on the first principal component of the correlation matrix of the nine component adjusted proportions. The following table shows close agreement on the form of the 1996 and 2001 distributions. Each has been derived with a *mean* of 1000 and a *standard deviation* of 100.

Table 7: Comparison of NZDep96 and NZDep2001 distributions

| <i>Quantile</i> | <i>NZDep96 score</i> | <i>NZDep2001 score</i> |
|-----------------------|--------------------------|----------------------------|
| 100% (most deprived) | 1528 | 1521 |
| 99% | 1315 | 1307 |
| 95% | 1202 | 1199 |
| 90% | 1140 | 1141 |
| 80% | 1073 | 1075 |
| 70% | 1032 | 1034 |
| 60% | 1000 | 1002 |
| 50% (median) | 975 | 976 |
| 40% | 954 | 953 |
| 30% | 936 | 934 |
| 20% | 917 | 916 |
| 10% | 897 | 895 |
| 0% (least deprived) | 830 | 834 |

- c) At least one of the nine component variables—the proportion below a household income threshold—is inevitably not identical from one Census to another.

Changes to the income categories in Census forms, due to changes in dollar values, give rise to changes in the household income variable, as this assumes the mid-point of the category as the income for the purpose of adding up incomes over family members (except for the last income bracket where sample survey data are used to estimate the median). This gives rise to a finite number of possible family incomes, depending on the number of earners in the family and what each of them is estimated to earn. In turn, this yields a finite number of equivalised household incomes (that is, incomes adjusted to take account of the size and composition of the household). From the distribution of people within these categories we have to decide which of these finite values will be the threshold below which we will define a household, or people, to have a 'low' equivalised household income. The threshold of equivalised household income used in 1996 was 17,100 'equivalised dollars', which cut off 13.9 percent of *households*; in 2001 it was 17,700 'equivalised dollars', which cut off 15.0 percent of *people*. (The change from household to people is due to the fact that, in 2001, Statistics New Zealand staff provided the information in the raw data set, whereas, in 1996, the information was calculated in the data laboratory.)

As a result of the inevitable changed proportions of individuals living in households below the equivalised income threshold, there is a slight difference in information being added to the composite NZDep index.

- d) One further variable—crowding—has been deliberately changed between the 1996 and 2001 censuses.

The crowding definition used in the 1996 NZDep calculations was the OECD definition which counted the number of people in a household and the number of bedrooms available to it (see Ulrich Cloher (1994)). A ratio of more than one 'equivalent' person per bedroom was defined to be 'crowded' for the purposes of establishing the proportion of people in a small area living in 'crowded'

accommodation. A person-equivalent was defined following Morrison (1994): children aged 10 and over are equivalent to one adult; children aged under 10 are equivalent to half an adult.

In the 2001 index we have improved our indicator of crowding by using the Canadian definition (Statistics New Zealand, 1998, p.79) which allows couples and certain small children (on the basis of their ages and sexes) to share a bedroom (see *Occupancy* under *Constructing the index*). This has resulted in a better performance for the indicator in the principal component analysis—whereas the OECD-defined variable in 1996 had a weight of 0.228 which was the lowest of the weights (range 0.228 – 0.363), the Canadian-defined variable in 2001 had a weight of 0.310, which was in closer alignment with the other eight coefficients (range 0.304 – 0.361).

As a result of the change in crowding definition, there is again a slight difference in information being added to the composite NZDep index.

As a result of all of the above, we conclude:

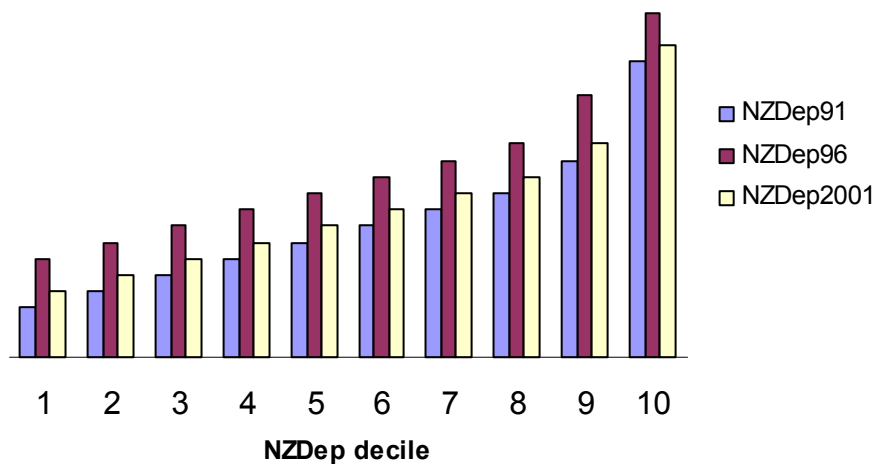
AREA COMPARISONS at the meshblock level, over time, should not be attempted. Comparisons at a higher aggregation, such as Territorial Authorities, or perhaps Area Units, may be less fraught, but we would still urge great caution in the interpretation of changes from one area to another.

Comparing relationships with deprivation over time

It is reasonable to compare relationships between deprivation deciles and a given outcome over time, for the same large area, using graphical approaches, time series regressions, etc. The hypothetical data in the figure below illustrate how such comparisons might be undertaken graphically. Each of the bars represents people living

in areas which are in nationally-defined deprivation deciles, and the nationally-defined deprivation deciles have a nearly consistent meaning, on a relative scale, regardless of time. The meaning of deciles changes only very slightly with each new index because of minor changes to the definitions of some variables included in the index.

Figure 2: Comparisons between deprivation deciles over time using hypothetical outcome data



As noted above, there are also technical reasons why caution should be exercised when observing minor changes in relationships. The reasoning is as follows. The NZDep index is created from proportions created for each small area. Changed small area boundaries may give rise to somewhat different constituent populations from which proportions are derived. This may result in changes in the final NZDep value for the constituent meshblocks for the small area (which are each given the small area NZDep value). Such a change, therefore, may have more to do with the boundary changes for the small area than any changed circumstances among the residents. Thus, if the deprivation indicator for a meshblock has changed for technical reasons, any change in a relationship involving the deprivation indicator may have been induced, at least partially, by the technical change in the indicator.

We conclude:

Comparing RELATIONSHIPS between deprivation and another variable, over time, may be less fraught, but we would still urge caution.

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