Department of Statistics, the University of Auckland
Summer Scholarship 2013–2014

Assessing Linkage Bias in the 1981–2006 Longitudinal Census Cohort

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Summer scholarship experience

The last 10 weeks have been a very significant aspect of my educational journey at the University of Auckland. Over this period, I got the chance to work with complex and messy real-life data sets containing as many as seven million observations. In working with these data sets, I have developed many skills that will assist me when entering postgraduate study and the working world in the future.

This project required me to work independently, and think statistically and critically when analysing and interpreting data. It was crucial that I checked over my working thoroughly and cautiously, make educated and critical judgements on whether the results I have found were appropriate and valid.

Furthermore, this project has given me a strong taste and hands-on experience of what postgraduate study is like. It also has given me the confidence to believe that statistics is what I want to continue doing in the future.

Summary

Recently, records in New Zealand censuses 1981–2006 have been linked, but not all were successfully linked. This incomplete linkage can result in a biased sample if the records linked differ in some key way from those unable to be linked. The aim of this project was to identify and investigate these differences, i.e. factors that strongly determined linkage.

This work is useful as researchers can use these factors to adjust for this bias in analyses. After adjusting for bias, the linked Census data would be a more accurate representation of the whole population. This would benefit researchers who wanted to use the linked census data to analyse, for example, longitudinal influences on mortality.

I found that the strongest factors determining linkage were: whether the individual lived at the same address five years ago; their NZDep score; whether they owned their residence; their ethnicity, their relationship status, and their sex.

Abstract

The aim of this project was to investigate factors strongly determining linkage across New Zealand Censuses. Of the 15 cohorts created in linking the 1981–2006 censuses, I analysed six: the five two-census cohorts and one three-census cohort.

To identify the factors determining linkage and their strengths for each of the cohorts, I calculated partial correlations between linkage and each of the census variables. I have discovered that the factors that strongly determined linkage across the six cohorts were very similar:
1. Whether or not the individual lived at the same address five years ago;
2. The individual's NZDep score
3. Whether or not the individual owned their residence;
4. The individual's ethnicity;
5. The individual's relationship status; and
6. The individual's sex.

1 Introduction

Recently, records have been linked between New Zealand Censuses 1981–2006. This means that eligible individuals in the 2006, 2001, 1996, 1991, and 1986 censuses were identified and 'linked' back to the previous censuses. To be eligible to be linked back one census, the individual must:

(a) Have been 5+ years old at the time; and
(b) Have been living in the country for 5+ years.

Not all eligible records were able to be successfully linked. Individuals may not have filled in correct and consistent information in the two censuses, or there may not have been enough information given for the individual to be identified in previous censuses.

Personal identifiers like names and addresses were not held electronically for the 1981–2006 censuses, so other variables such as date of birth, sex, usual residence five years ago, and area unit had to be used to link records across censuses.

Linking the 1981–2006 censuses created 15 cohorts – shown in Table 1. The shaded box in each row represents a single cohort, and the number displayed within that box is the number of individuals that were successfully linked. For example, the 060196 cohort shows that there were 1,592,000 individuals linked from 2006–2001–1996.

Table 1: Cohorts created in linking the 1981–2006 censuses

Name of cohort	1981	1986	1991	1996	2001	2006
0601					2,311,000	
0196				2,171,000		
9691			2,174,000			
9186		2,220,000				
8681	2,078,000					
060196					1,592,000	
019691				1,571,000		
969186			1,603,000			
918681		1,581,000				
06019691				1,173,000		
01969186			1,177,000			
96918681		1,154,000				
0601969186				882,000		
0196918681			850,000			
060196918681			647,000			

A point that should be recognised is that as the cohorts get wider in the diagram, the number of individuals successfully linked decreases. We're less likely to find individuals with consistent information over a larger number of censuses, and the eligibility requirements are more stringent. To be eligible for linkage between 2006 and 2001, an individual had to have been 5+ years old and to have lived in New Zealand for 5+ years, in 2006, whereas to be eligible for linkage between 2006 and 1981, an individual had to have been 25+ years old and to have lived in New Zealand for 25+ years, in 2006.

The wider cohorts are subsets of the narrower cohorts. Individuals were linked backwards and no gaps were permitted. Overall between census pairs, approximately 70% of eligible records were linked. Researchers may want to use these linked data to analyse things like occupation changes over time or

longitudinal influences on mortality, and the incomplete linkage can result in a biased sample of the population if the records linked differ in some key way from those unable to be linked.

The aim of this project was to identify and investigate these differences, i.e. the factors that strongly determine linkage across censuses. I analysed six of the 15 cohorts: all two-census cohorts, i.e. 0601, 0196, 9691, 9186, 8681, and one three-census cohort, 060196.

2 Methods

Starting with the 2006–2001 cohort, I identified all variables from the data set using the 2006 Data Dictionary. This data set contained majority of the information about each individual (that was eligible to be linked back one census) in the 2006 census, and whether or not they were linked back to the 2001 census. There were also other important variables, such as Sex, NZDep and Ethnicity, that weren't located in this data set, but in other datasets. By merging these datasets together, I created a new data set which contained all these variables that I may have used in my analysis.

Secondly, I picked out and kept the variables which could possibly be causing bias between those records that are linked and those that are not linked. I then edited these variables – changing them all to numeric variables, simplifying the values they can take, and changing those who answered 'not specified' as 9's. I also rearranged the categorical variables into an order so that we could maximize the correlation between that variable and the linkage variable. Thirdly, I created two way frequency tables of all these variables with linkage. These tables allowed us to see the extent of the linkage bias we aim to search for.

Next, I created two correlation matrices. In the first matrix, I included all variables that I had planned to later on analyse with linkage. I used this matrix to identify all redundant variables and remove them from my analysis. I identified a redundant variable as one which was strongly correlated (i.e. greater than |0.8|) to another variable. In the second matrix, I included all variables including the linkage variable. After doing all this, I was then able to find the partial correlations between each of the variables and linkage.

Finally, I created a new data set for this cohort, which I named 'final_dataset0601'. This data set contains all the variables that I had created, plus the original age and years since arrival to NZ variable.

I repeated this process with the other five cohorts I have analysed. However, with the three-census cohort, 2006–2001–1996 I had to have a few extra steps at the start of the process. I had to create a data set which contained all those individuals that were eligible to be linked back from 2006 to 1996, as this was not given to us like it was in the two census cohorts. To do this I merged together those individuals that were eligible to be linked back from 2006 to 2001 and those eligible to be linked back from 2001 to 1996. I then narrowed the population down to only those individuals who were 10+ years old and have been in the country for 10+ years. This was because those who are younger than 10 or have lived in the country for less than 10 years could not possibly have been linked back 2 censuses ago. I then created a variable 'linkind060196' which indicated if an individual was linked from 2006 to 1996 or not. After these extra steps, the same process as for all other cohorts was followed.

3 Results

For each cohort I have analysed, I have listed the ten most strongly correlated variables in determining linkage in the tables below. The variables are listed in order of strength based on their absolute partial correlation coefficient I have found. I ordered them by absolute value so I could focus solely on the strength of the relationship between the variable and linkage, rather than both strength and direction.

In each of these tables I have included the name of the variable, the bivariate correlation with the linkage variable, the absolute bivariate correlation with the linkage variable, the partial correlation with the linkage variable, and lastly the absolute partial correlation with the linkage variable.

I have called the linkage variable 'linkindxxxx' in my analysis. This is a binary variable which indicates whether or not the individual was linked back to the previous census or censuses. 'xxxx' represents the years the linkage is between (i.e. 'xxxx' in {0601,0196,9691,9186,8681,060196}). For example, 'linkind0601' is the name of the binary variable which states whether the individual was linked from 2006 to 2001.

Table 2: Correlations of variables with linkage for each cohort

	0601 cohort	correlation with linkind0601	absolute value	partial correlation with linkind0601	absolute value
1	Same address 5 years ago	0.34471	0.34471	0.2462	0.2462
2	NZDep score	-0.12907	0.12907	-0.04387	0.04387
3	Own residence	0.22449	0.22449	0.04351	0.04351
4	Marital status	-0.17742	0.17742	-0.04348	0.04348
5	Māori descent	-0.15344	0.15344	-0.0422	0.0422
6	European ethnicity	0.11352	0.11352	0.04183	0.04183
7	Years lived in NZ	0.10308	0.10308	0.0418	0.0418
8	Live with partner	0.09392	0.09392	0.04165	0.04165
9	Sex	0.04189	0.04189	0.03963	0.03963
10	Other ethnicity[1]	0.04238	0.04238	0.0357	0.0357

	0196 cohort	correlation with linkind0196	absolute value	partial correlation with linkind0196	absolute value
1	Same address 5 years ago	0.28444	0.28444	0.13189	0.13189
2	Years lived at address	0.26773	0.26773	0.06051	0.06051
3	Own residence	0.22318	0.22318	0.0488	0.0488
4	Live with partner	0.10137	0.10137	0.04744	0.04744
5	European ethnicity	0.15887	0.15887	0.04685	0.04685
6	NZ Languages spoken[2]	-0.14144	0.14144	-0.04505	0.04505
7	NZDep score	-0.12192	0.12192	-0.04185	0.04185
8	Māori descent	-0.1326	0.1326	-0.04022	0.04022
9	Sex	0.04109	0.04109	0.03979	0.03979
10	Marital status	-0.18408	0.18408	-0.03833	0.03833

	9691 cohort	correlation with linkind9691	absolute value	partial correlation with linkind9691	absolute value
1	Same address 5 years ago	0.32355	0.32355	0.22453	0.22453
2	European ethnicity	0.15994	0.15994	0.05063	0.05063
3	Live with partner	0.11668	0.11668	0.04844	0.04844
4	Marital status	-0.17242	0.17242	-0.04802	0.04802
5	NZDep score	-0.11319	0.11319	-0.04511	0.04511
6	Years lived in NZ	0.09624	0.09624	0.03824	0.03824
7	Māori descent	-0.13421	0.13421	-0.03755	0.03755
8	Smoke	-0.1341	0.1341	-0.03713	0.03713
9	Benefit income	-0.10471	0.10471	-0.03621	0.03621
10	Sex	0.03911	0.03911	0.03493	0.03493

	9186 cohort	**correlation with linkind9186**	**absolute value**	**partial correlation with linkind9186**	**absolute value**
1	*Years lived at address*	0.24583	0.24583	0.21459	0.21459
2	*Same address 5 years ago*	-0.09539	0.09539	-0.13025	0.13025
3	*European ethnicity*	0.18745	0.18745	0.08953	0.08953
4	*Live with partner*	0.14525	0.14525	0.06961	0.06961
5	*NZDep score*	-0.12809	0.12809	-0.05387	0.05387
6	*School qualification*	0.07461	0.07461	0.03789	0.03789
7	*Live with children*	0.05578	0.05578	0.03344	0.03344
8	*Live with parents*	0.02643	0.02643	0.03255	0.03255
9	*Māori descent*	-0.08897	0.08897	-0.03095	0.03095
10	*Sex*	0.03084	0.03084	0.02686	0.02686

	8681 cohort	**correlation with linkind8681**	**absolute value**	**partial correlation with linkind8681**	**absolute value**
1	*Same address 5 years ago*	0.32389	0.32389	0.199	0.199
2	*European ethnicity*	0.16544	0.16544	0.05502	0.05502
3	*Years lived at address*	0.26859	0.26859	0.05378	0.05378
4	*Born in NZ*	0.04354	0.04354	0.04404	0.04404
5	*Years lived in NZ*	0.02489	0.02489	0.04304	0.04304
6	*Māori ethnicity*	-0.12183	0.12183	-0.03667	0.03667
7	*Pacific ethnicity*	-0.06629	0.06629	-0.02716	0.02716
8	*Defacto status*	-0.0855	0.0855	-0.02656	0.02656
9	*Work and labour force status*	0.03662	0.03662	0.02383	0.02383
10	*Religiosity*	0.05885	0.05885	0.02069	0.02069

	060196 cohort	**correlation with linkind060196**	**absolute value**	**partial correlation with linkind060196**	**absolute value**
1	*Npairs sameaddress[3]*	0.50011	0.50011	0.45097	0.45097
2	*Years lived at address from 06*	0.26636	0.26636	-0.15048	0.15048
3	*Years lived at address from 01*	0.25418	0.25418	0.10848	0.10848
4	*Sex in 06*	0.04670	0.0467	0.04723	0.04723
5	*Marital status in 06*	-0.17619	0.17619	-0.04123	0.04123
6	*NZDep score in 06*	-0.12282	0.12282	-0.0409	0.0409
7	*Marital status in 01*	-0.13672	0.13672	-0.04065	0.04065
8	*European ethnicity in 06*	0.10673	0.10673	0.03864	0.03864
9	*Live with partner in 06*	0.0838	0.0838	0.03609	0.03609
10	*Māori descent in 06*	-0.14622	0.14622	-0.03422	0.03422

[1] Whether the individual specified an ethnicity other than European, Māori, Pacific, Asian, or MELAA

[2] Whether the individual spoke English and/or Māori

[3] The number of times out of two censuses (06 and 01) that the individual specified that they lived at the same address five years ago

The first three tables show similar characteristics to each other. They indicate that the strongest variable that determines linkage in the 0601, 0196, and 9691 cohorts is *same address 5 years ago*. This variable scored the highest absolute partial correlation, ranging between 0.132 and 0.246. This variable also had the highest absolute bivariate correlation in each of the tables, ranging from 0.284 to 0.345. The other 9 variables on each of these tables had relatively small absolute partials, ranging from 0.035 to 0.060. Another similarity is the variables that appear in those first three cohort tables: *same address 5 years ago*, *NZDep score, marital status, Māori descent, European ethnicity, live with partner*, and *sex* appeared in all three.

The 9186 cohort varied slightly from the previous three in the sense that there were two dominant variables determining linkage: y*ears lived at address* and *same address 5 years ago* had absolute partial correlations of 0.215 and 0.130 respectively. The other 8 variables had relatively small partial correlations ranging from 0.0269 to 0.090. The variables were similar to those in the previous three cohorts: *same address 5 years ago*, *European ethnicity, live with partner, NZDep score, Māori descent,* and *sex* were in the top ten in all of these.

The 8681 cohort again had *same address 5 years ago* dominating, with an absolute partial correlation of 0.199 and absolute bivariate correlation of 0.324. The other 9 variables for this cohort had relatively small absolute partial correlations, ranging from 0.021 to 0.055, and quite a few of these variables were different from those that showed up in the first four cohorts. *Born in NZ, Māori ethnicity, Pacific ethnicity, Defacto status, work and labour force status, and religiosity* were unique to this cohort as top 10 variables.

The three-census cohort of 060196 had *npairs sameaddress* as most important, followed by *years lived at address from 06* and *years lived at address from 01*. These three variables had absolute partial correlations of 0.451, 0.150, and 0.109 respectively. The other 7 variables for this cohort had relatively small absolute partial correlations, ranging from 0.034 to 0.047.

4 Discussion

Our results show that the factors that strongly determine linkage vary across the different two-census cohorts. Variables that appeared often among the two-census cohorts were:
- Same address 5 years ago;
- NZDep score;
- Marital status;
- Own residence;
- European ethnicity;
- Māori descent;
- Live with partner;
- Sex.

The strongest variable determining linkage across two censuses was *Same address 5 years ago*. It had the strongest partial correlation with linkage in four of the five two-census cohorts. For the three-census cohort, the most important variables were predominantly 2006 variables; the strongest was *npairs sameaddress*, which counted the number of times the individual reported having lived at the same address five years ago, 0, 1, or 2, in the 2001 and 2006 censuses. However, this variable is superficially strong, because those not linked from 2006 to 2001 cannot have 2001 data, and so cannot have valid data for *same address 5 years ago* in 2001. So linkage from 2006 to 2001 partly determines the score on this variable and it is not surprising that it was strongly correlated with 060196.

Analysing cohorts with more than two censuses is more complicated: there are multiple versions of variables to deal with, and as covered above, creating variables to summarise their values over time is problematic. For the longest cohorts we also had problems with less data documentation available at the time for the 1981 and 1986 censuses, making it harder to identify common variables and compatible formats. Thus there was only a handful of variables available to analyse for the longer cohorts. This is also one reason why the top 10 variables we saw for the 8681 cohort differed significantly from those for the other cohorts: we were limited by the variables we could identify in those data sets.

A disadvantage of using correlations to analyse the strength of these variables in determining linkage is that the correlation coefficients only measure linear relationships between variables. Age was not in any of our results because it had a very weak partial correlation with linkage across all cohorts; the relationship was non-linear. The lowest linkage rate was observed around age 25, where only about 50% of eligible records were linked; and the highest was around age 70, with 80%. These observations are due to lifestage transitions and the mobility levels of these groups (Statistics NZ 2013). And there may be other variables with non-linear relationships with linkage that we failed to capture in these analyses.

We could also have used other methods to identify and rank the factors most strongly determining linkage. Thompson (2009) compared six methods for ranking the strength of associations: *standardised coefficients*, *the Wald chi-square test*, *adequacy*, the *c-statistic*, and *the information value*, which could also have been appropriate here. These methods were found to not be equivalent – some yielded very different results to others, and each had its own advantages and disadvantages. The *Wald chi-square test* indicated the strength of evidence that the two groups – in terms of our analysis, those linked and those not – differed from each other. However, a disadvantage of using p-values is that they do not indicate the magnitude by which groups differ. Overall, it is unclear which is the best method – perhaps using multiple methods would be the best way to increase our reliability here.

After analysing all fifteen cohorts and finding the extent to which each variable determined linkage, the next step would be to determine how to adjust for the bias this caused. Weights would have to be created for each variable combination, calculated as the inverse of the linkage probability. The weighted linked census population would then be a more accurate representation of the whole population.

5 References

Statistics New Zealand (2013). Developing a historic longitudinal dataset in New Zealand: A feasibility study. http://archive.stats.govt.nz/~/media/Statistics/surveys-and-methods/methods/data-integration/longitudinal-census-feasibility-study.pdf

Thompson D (2009). Ranking Predictors in Logistic Regression. Paper D10–2009. http://www.mwsug.org/proceedings/2009/stats/MWSUG-2009-D10.pdf

Appendices

The table below lists all of the variables involved in our analyses, with alternative naming conventions for the different census years, and descriptions of what each variable represents.

Variable name	Description
LinkindXXXX	Whether the individual was linked back to the previous census (or censuses), XXXX = year
adult	Whether the individual is an adult
age	The age of the individual
AsianXX	Whether the individual is Asian in the year XX
benefit_income	Whether the individual is on a benefit
children_born	The number of children the individual has given birth to
currently_separated	Whether the individual is separated from their partner
defacto_status	The individual's defacto status
difficulty_acty_count	Number of activities the individual has difficulties with
disability	Whether the individual has a long term disability (lasting 6 months or more)
disability_ind, longterm_disability	Whether the individual indicated any difficulties with an activity
EthNS	Whether or not the individual indicated their ethnicity
EurXX	Whether the individual is European in the year XX
health_problems	Whether the individual indicated any difficulties with an activity
highest_qual, highest_qualification	The individual's highest qualification
hrs_work_mainjob	Number of hours the individual works in main job
income_source_count	Number of income sources the individual has
income_support	Whether the individual is on income support
iwi_count	The number of iwi the individual has
iwi_ind	Whether the individual specified if they have any iwi
Language_count	The number of languages the individual speaks
language_indicator	Whether the individual speaks just English, just Māori, both or neither
live_alone	Whether the individual lives alone
live_with_children	Whether the individual lives with their children
live_with_flatmates	Whether the individual lives with flatmates
live_with_other	Whether the individual lives with people other than relatives and flatmates
live_with_other_rel	Whether the individual lives with relatives other than parents, children, siblings, or partner
live_with_parents	Whether the individual lives with their parents
live_with_partner, live with spouse	Whether the individual lives with their partner
live_with_siblings	Whether the individual lives with their siblings
maori_ancestry, maori_descent	Whether the individual is of Māori descent
MaoXX	Whether the individual is Māori in the year XX
marital_status_legal	The individual's marital status
MELAA01	Whether the individual is Middle Eastern/Latin American/African in XX
NZ_born	Whether the individual is born in NZ
NZdepXXXX	The individual's NZ Deprivation Score in the year XXXX
OtherXX	Whether the individual specified an ethnicity other than European, Pacific, Asian, MELAA, Māori
own_residence	Whether the individual owns their residence
Pac01	Whether the individual is pacific in year XX
religious	Whether the individual is religious

Variable name	Description
same_addr_5yrs_ago	Whether the individual lived at the same address 5 years ago, or didn't specify
school_qual	Whether the individual has a school qualification
sex_female	Whether the individual is female
smoke	Whether the individual smokes
travel_work	How the individual travels to work
ttl_personal_income	The individual's personal income
ttl_work_hrs	The total number of hours the individual worked
unpaid_acty_count	The number or unpaid activities the individual has done in the last 7 days
unpaid_work	Whether the individual did any unpaid work over the last 7 days
work_at_home	Whether the individual works at home
work_labour_force_status	The individual's work and labour force status
yrs_at_addr	The number of years the individual has lived at their current address

The next set of tables lists the correlations and partial correlations for all appropriate variables for each cohort.

	Corr with LinkInd0601	abs(corr)
same_addr_5yrs_ago	0.34471	0.34471
yrs_at_addr	0.23216	0.23216
own_residence	0.22449	0.22449
marital_status_legal	-0.17742	0.17742
income_support	-0.15636	0.15636
maori_descent	-0.15344	0.15344
language_indicator	-0.14453	0.14453
smoke	-0.1428	0.1428
income_source_count	0.14116	0.14116
NZDep2006	-0.12907	0.12907
ttl_personal_income	0.11835	0.11835
Mao06	-0.11677	0.11677
Eur06	0.11352	0.11352
unpaid_acty_count	0.10681	0.10681
yrs_in_NZ	0.10308	0.10308
difficulty_acty_count	-0.10039	0.10039
highest_qual	0.10027	0.10027
live_with_partner	0.09392	0.09392
live_with_flatmates	-0.08808	0.08808
disability_ind	-0.08801	0.08801
benefit_income	-0.08575	0.08575
iwi_count	-0.08563	0.08563
children_born	0.0852	0.0852
religious	0.08367	0.08367
age	0.07602	0.07602
Pac06	-0.07451	0.07451
hrs_work_mainjob	-0.07055	0.07055
EthNS	-0.06299	0.06299
travel_work	-0.06036	0.06036
work_labour_force_status	0.05197	0.05197
live_with_children	0.04356	0.04356
Asian06	-0.04279	0.04279
Other06	0.04238	0.04238
sex_female	0.04189	0.04189
adult	0.02732	0.02732
MELAA06	-0.02313	0.02313
live_with_other	-0.02159	0.02159
live_with_siblings	0.00666	0.00666
live_alone	0.00646	0.00646
Language_count	0.00522	0.00522
live_with_parents	0.00466	0.00466

	partial corr with linkind0601	abs(partial corr)
same_addr_5yrs_ago	0.2462	0.2462
nzdep2006	-0.04387	0.04387
own_residence	0.04351	0.04351
marital_status_legal	-0.04348	0.04348
maori_descent	-0.0422	0.0422
Eur06	0.04183	0.04183
yrs_in_NZ	0.0418	0.0418
live_with_partner	0.04165	0.04165
sex_female	0.03963	0.03963
Other06	0.0357	0.0357
income_source_count	0.03556	0.03556
religious	0.03424	0.03424
language_indicator	-0.03345	0.03345
smoke	-0.03328	0.03328
Pac06	-0.02705	0.02705
live_with_children	0.02625	0.02625
benefit_income	-0.02611	0.02611
highest_qual	0.02419	0.02419
live_with_siblings	0.02285	0.02285
difficulty_acty_count	-0.02261	0.02261
live_with_parents	0.02226	0.02226
unpaid_acty_count	0.02017	0.02017
age	0.01824	0.01824
ttl_personal_income	0.01722	0.01722
hrs_work_mainjob	-0.0147	0.0147
Mao06	-0.0143	0.0143
iwi_count	-0.01184	0.01184
live_alone	0.01127	0.01127
live_with_flatmates	-0.01119	0.01119
disability_ind	-0.0072	0.0072
income_support	0.00608	0.00608
adult	-0.00562	0.00562
MELAA06	-0.00492	0.00492
live_with_other	0.00329	0.00329
Language_count	-0.00298	0.00298
EthNS	-0.00206	0.00206
Asian06	0.00098	0.00098
yrs_at_addr	-0.00079	0.00079
travel_work	-0.00079	0.00079

	corr with LinkInd0196	abs(corr)
same_addr_5yrs_ago	0.28444	0.28444
yrs_at_addr	0.26773	0.26773
own_residence	0.22318	0.22318
marital_status_legal	-0.18408	0.18408
income_support	-0.16246	0.16246
Eur01	0.15887	0.15887
language_indicator	-0.14144	0.14144
maori_descent	-0.1326	0.1326
nzdep2001	-0.12192	0.12192
currently_separated	-0.12083	0.12083
income_source_count	0.11996	0.11996
Mao01	-0.11977	0.11977
ttl_personal_income	0.10574	0.10574
benefit_income	-0.10363	0.10363
live_with_partner	0.10137	0.10137
live_with_flatmates	-0.09411	0.09411
unpaid_acty_count	0.08858	0.08858
difficulty_acty_count	-0.08812	0.08812
iwi_count	-0.08679	0.08679
iwi_ind	0.08206	0.08206
highest_qual	0.08203	0.08203
religious	0.08169	0.08169
age	0.07777	0.07777
disability_ind	-0.07719	0.07719
EthNS	-0.07647	0.07647
Pac01	-0.0731	0.0731
disability	-0.06722	0.06722
work_labour_force_status	0.05742	0.05742
work_at_home	0.05492	0.05492
travel_work	-0.05149	0.05149
NZ_born	0.04821	0.04821
sex_female	0.04109	0.04109
live_with_other	-0.04108	0.04108
live_with_children	0.04058	0.04058
hrs_work_mainjob	0.03486	0.03486
yrs_in_NZ	0.02729	0.02729
Asian01	-0.02542	0.02542
adult	0.02531	0.02531
MELAA01	-0.01505	0.01505
live_with_parents	0.00509	0.00509
live_with_siblings	0.00357	0.00357
live_alone	0.00351	0.00351
Other01	-0.00242	0.00242
Language_count	0.00075	0.00075

	partial corr with linkind0196	abs(partial corr)
same_addr_5yrs_ago	0.13189	0.13189
yrs_at_addr	0.06051	0.06051
own_residence	0.0488	0.0488
live_with_partner	0.04744	0.04744
Eur01	0.04685	0.04685
language_indicator	-0.04505	0.04505
nzdep2001	-0.04185	0.04185
maori_descent	-0.04022	0.04022
sex_female	0.03979	0.03979
marital_status_legal	-0.03833	0.03833
religious	0.03319	0.03319
income_source_count	0.03268	0.03268
highest_qual	0.03008	0.03008
unpaid_acty_count	0.02955	0.02955
live_with_children	0.02678	0.02678
live_with_parents	0.0242	0.0242
Pac01	-0.0212	0.0212
live_with_siblings	0.02119	0.02119
ttl_personal_income	0.01889	0.01889
difficulty_acty_count	-0.01805	0.01805
live_alone	0.01588	0.01588
benefit_income	-0.01547	0.01547
iwi_ind	0.01295	0.01295
work_labour_force_status	0.01156	0.01156
travel_work	0.0115	0.0115
NZ_born	0.00949	0.00949
age	0.00901	0.00901
Mao01	-0.00887	0.00887
EthNS	-0.00844	0.00844
Asian01	0.00753	0.00753
disability	-0.00627	0.00627
work_at_home	-0.00601	0.00601
live_with_flatmates	-0.00599	0.00599
income_support	-0.00553	0.00553
iwi_count	0.0049	0.0049
adult	-0.00465	0.00465
hrs_work_mainjob	-0.00448	0.00448
disability_ind	-0.00349	0.00349
currently_separated	-0.0029	0.0029
live_with_other	-0.00235	0.00235
MELAA01	-0.00194	0.00194
Language_count	-0.00166	0.00166
Other01	0.00038	0.00038
yrs_in_NZ	0.00003	0.00003

	corr with LinkInd9691	Abs(corr)
same_addr_5yrs_ago	0.32355	0.32355
yrs_at_addr	0.24187	0.24187
marital_status_legal	-0.17242	0.17242
Eur96	0.15994	0.15994
maori_ancestry	-0.13421	0.13421
smoke	-0.1341	0.1341
live_with_partner	0.11668	0.11668
NZdep1996	-0.11319	0.11319
Language_count	-0.11123	0.11123
Mao96	-0.11013	0.11013
benefit_income	-0.10471	0.10471
income_source_count	0.1009	0.1009
ttl_personal_income	0.09754	0.09754
yrs_in_NZ	0.09624	0.09624
EthNS	-0.0911	0.0911
children_born	0.08734	0.08734
health_problems	-0.08499	0.08499
religious	0.083	0.083
unpaid_work	0.08049	0.08049
disability	-0.07909	0.07909
live_with_children	0.07846	0.07846
live_with_parents	-0.07223	0.07223
longterm_disability	-0.07163	0.07163
Pac96	-0.06996	0.06996
unpaid_acty_count	0.0691	0.0691
highest_qualification	0.06884	0.06884
age	0.06581	0.06581
NZ_born	0.06202	0.06202
work_labour_force_status	0.05415	0.05415
live_with_siblings	-0.04297	0.04297
sex_female	0.03911	0.03911
language_indicator	0.03699	0.03699
Asian96	-0.02621	0.02621
adult	0.01565	0.01565
hrs_work_mainjob	-0.01398	0.01398
MELAA96	-0.00772	0.00772
Other96	-0.0022	0.0022

	partial corr with linkind9691	abs(partial corr)
same_addr_5yrs_ago	0.22453	0.22453
Eur96	0.05063	0.05063
live_with_partner	0.04844	0.04844
marital_status_legal	-0.04802	0.04802
NZdep1996	-0.04511	0.04511
yrs_in_NZ	0.03824	0.03824
maori_ancestry	-0.03755	0.03755
smoke	-0.03713	0.03713
benefit_income	-0.03621	0.03621
sex_female	0.03493	0.03493
hrs_work_mainjob	-0.03481	0.03481
religious	0.03433	0.03433
income_source_count	0.03408	0.03408
live_with_children	0.0272	0.0272
ttl_personal_income	0.02567	0.02567
highest_qualification	0.01969	0.01969
health_problems	-0.01914	0.01914
Language_count	-0.01879	0.01879
Pac96	-0.01877	0.01877
Mao96	-0.01737	0.01737
work_labour_force_status	0.0151	0.0151
yrs_at_addr	0.01375	0.01375
unpaid_work	0.01319	0.01319
age	-0.01196	0.01196
Asian96	0.01178	0.01178
adult	-0.01134	0.01134
longterm_disability	-0.01062	0.01062
EthNS	-0.00728	0.00728
live_with_siblings	0.00719	0.00719
language_indicator	0.00602	0.00602
live_with_parents	-0.005	0.005
disability	-0.00274	0.00274
unpaid_acty_count	0.00239	0.00239
MELAA96	0.00122	0.00122
Other96	0.00026	0.00026

	corr with LinkInd9186	abs(corr)
yrs_at_addr	0.24583	0.24583
Eur91	0.18745	0.18745
live_with_spouse	0.14525	0.14525
Mao91	-0.1339	0.1339
NZdep1991	-0.12809	0.12809
Pac91	-0.09745	0.09745
live_with_other_rel	-0.09564	0.09564
same_addr_5yrs_ago	-0.09539	0.09539
maori_ancestry	-0.08897	0.08897
school_qual	0.07461	0.07461
work_labour_force_status	0.07101	0.07101
age	0.06502	0.06502
EthNS	-0.06087	0.06087
religious	-0.06078	0.06078
live_with_children	0.05578	0.05578
NZ_born	0.04188	0.04188
sex_female	0.03084	0.03084
ttl_work_hrs	0.0296	0.0296
hrs_work_mainjob	0.0288	0.0288
Asian91	-0.0274	0.0274
live_with_parents	0.02643	0.02643
live_with_siblings	0.02603	0.02603
adult	0.00789	0.00789
MELAA91	-0.0055	0.0055
Other91	-0.001	0.001

	Partial corr with linkind9186	abs(partial corr)
yrs_at_addr	0.21459	0.21459
same_addr_5yrs_ago	-0.13025	0.13025
Eur91	0.08953	0.08953
live_with_spouse	0.06961	0.06961
NZdep1991	-0.05387	0.05387
school_qual	0.03789	0.03789
live_with_children	0.03344	0.03344
live_with_parents	0.03255	0.03255
maori_ancestry	-0.03095	0.03095
sex_female	0.02686	0.02686
EthNS	0.02679	0.02679
work_labour_force_stat	0.02658	0.02658
live_with_siblings	0.02316	0.02316
age	0.02024	0.02024
adult	-0.01433	0.01433
NZ_born	0.01257	0.01257
religious	-0.0092	0.0092
Asian91	0.00885	0.00885
live_with_other_rel	-0.00874	0.00874
MELAA91	0.00258	0.00258
hrs_work_mainjob	-0.00256	0.00256
Mao91	-0.00117	0.00117
Other91	0.00087	0.00087

	corr with LinkInd8681	abs(corr)
same_addr_5yrs_ago	0.32389	0.32389
yrs_at_addr	0.26859	0.26859
Eur86	0.16544	0.16544
Mao86	-0.12183	0.12183
defacto_status	-0.0855	0.0855
EthNS	-0.08094	0.08094
Pac86	-0.06629	0.06629
Religious	0.05885	0.05885
age	0.053	0.053
NZ_Born	0.04354	0.04354
work_labour_force_status	0.03662	0.03662
yrs_in_NZ	0.02489	0.02489
sex_female	0.01979	0.01979
Asian86	-0.01647	0.01647
labour_force_dummy	0.01223	0.01223
ttl_work_hrs	0.00741	0.00741
hrs_work_mainjob	0.00531	0.00531
Other86	-0.00425	0.00425
MELAA86	-0.00292	0.00292
adult	0.00148	0.00148

	partial corr with linkind8681	abs(partial corr)
same_addr_5yrs_ago	0.199	0.199
Eur86	0.05502	0.05502
yrs_at_addr	0.05378	0.05378
NZ_Born	0.04404	0.04404
yrs_in_NZ	0.04304	0.04304
Mao86	-0.03667	0.03667
Pac86	-0.02716	0.02716
defacto_status	-0.02656	0.02656
work_labour_force_status	0.02383	0.02383
Religious	0.02069	0.02069
age	-0.01865	0.01865
sex_female	0.01772	0.01772
Asian86	0.00715	0.00715
ttl_work_hrs	0.00645	0.00645
hrs_work_mainjob	-0.00345	0.00345
MELAA86	0.00223	0.00223
EthNS	0.00171	0.00171
adult	0.00157	0.00157
Other86	0.00014	0.00014

	corr with linkind060196	abs(corr)
linkind060196	1	1
LinkInd0196	1	1
LinkInd0601	0.69894	0.69894
npairs_sameaddress	0.50011	0.50011
same_addr_5yrs_ago06	0.30823	0.30823
same_addr_5yrs_ago01	0.29018	0.29018
yrs_at_addr06	0.26636	0.26636
yrs_at_addr01	0.25418	0.25418
own_residence06	0.21478	0.21478
marital_status_legal06	-0.17619	0.17619
own_residence01	0.15709	0.15709
income_support06	-0.1473	0.1473
maori_descent06	-0.14622	0.14622
smoke06	-0.13929	0.13929
marital_status_legal01	-0.13672	0.13672
Mao06	-0.13435	0.13435
age_code_num_06	0.13422	0.13422
income_source_count06	0.13093	0.13093
nzdep2006	-0.12282	0.12282
language_indicator06	-0.12184	0.12184
Eur06	0.10673	0.10673
Eur01	0.10615	0.10615
age_code_num_01	0.10517	0.10517
benefit_income06	-0.10015	0.10015
iwi_count06	-0.09872	0.09872
income_support01	-0.09852	0.09852
age06	0.0939	0.0939
Mao01	-0.09325	0.09325
religious06	0.08907	0.08907
ttl_personal_income06	0.08781	0.08781
nzdep2001	-0.0877	0.0877
live_with_flatmates01	-0.08733	0.08733
benefit_income01	-0.08633	0.08633
live_with_partner06	0.0838	0.0838
live_with_flatmates06	-0.08141	0.08141
maori_descent01	-0.07954	0.07954
difficulty_acty_count06	-0.07895	0.07895
Pac06	-0.0759	0.0759
highest_qual06	0.0755	0.0755
language_indicator01	-0.07413	0.07413
age01	0.07347	0.07347
iwi_count01	-0.06977	0.06977
yrs_in_NZ06	0.06836	0.06836
iwi_ind01	0.06817	0.06817
currently_separated01	-0.06764	0.06764
income_source_count01	0.06553	0.06553
disability_ind06	-0.06433	0.06433
unpaid_acty_count06	0.06266	0.06266
live_with_partner01	0.05833	0.05833
Pac01	-0.05772	0.05772
religious01	0.05665	0.05665
EthNS2006	-0.04805	0.04805
sex_female06	0.0467	0.0467
difficulty_acty_count01	-0.03857	0.03857
ttl_personal_income01	0.03751	0.03751
travel_work06	-0.03463	0.03463
Other06	0.03412	0.03412
live_with_other01	-0.03235	0.03235
unpaid_acty_count01	0.03176	0.03176
disability_ind01	-0.02678	0.02678
highest_qual01	0.02677	0.02677
live_with_other06	-0.0262	0.0262
sex_female01	0.0258	0.0258
adult06	0.02518	0.02518
work_labour_force_status01	0.02499	0.02499
EthNS2001	-0.02493	0.02493
Language_count01	-0.02228	0.02228
adult01	0.02165	0.02165
Asian06	-0.02133	0.02133
years_in_nz_code_num_06	-0.02119	0.02119
disability01	-0.02034	0.02034
Asian01	-0.0189	0.0189
live_with_children01	0.0187	0.0187
yrs_in_NZ01	0.01674	0.01674
work_at_home01	0.01549	0.01549
MELAA06	-0.01361	0.01361
live_alone06	0.01179	0.01179
travel_work01	-0.00943	0.00943
hrs_work_mainjob01	-0.00845	0.00845
NZ_born01	0.00828	0.00828
MELAA01	-0.00824	0.00824
Language_count06	-0.00715	0.00715
years_in_NZ_code_num_01	-0.00598	0.00598
live_with_children06	0.00542	0.00542
live_alone01	0.00514	0.00514
hrs_work_mainjob06	0.00479	0.00479
live_with_parents06	0.00219	0.00219
live_with_parents01	-0.00172	0.00172
Other01	-0.00094	0.00094
live_with_siblings01	0.00085	0.00085
live_with_siblings06	0.00033	0.00033

	Partial corr with linkind060196	abs(partial corr)
npairs_sameaddress	0.45097	0.45097
yrs_at_addr06	-0.15048	0.15048
yrs_at_addr01	0.10848	0.10848
sex_female06	0.04723	0.04723
marital_status_legal06	-0.04123	0.04123
nzdep2006	-0.0409	0.0409
marital_status_legal01	-0.04065	0.04065
Eur06	0.03864	0.03864
live_with_partner06	0.03609	0.03609
maori_descent06	-0.03422	0.03422
religious06	0.03382	0.03382
income_source_count06	0.03336	0.03336
Pac06	-0.03303	0.03303
Other06	0.03281	0.03281
own_residence01	0.03162	0.03162
language_indicator06	-0.03114	0.03114
smoke06	-0.02966	0.02966
live_with_children01	0.02945	0.02945
own_residence06	0.02587	0.02587
yrs_in_NZ06	0.02577	0.02577
benefit_income01	-0.02413	0.02413
income_source_count01	0.02412	0.02412
benefit_income06	-0.02404	0.02404
Eur01	0.02389	0.02389
highest_qual06	0.02257	0.02257
language_indicator01	-0.02162	0.02162
maori_descent01	-0.02122	0.02122
live_with_parents01	0.02056	0.02056
highest_qual01	0.01996	0.01996
difficulty_acty_count06	-0.01948	0.01948
live_with_siblings01	0.01904	0.01904
live_with_partner01	0.01882	0.01882
religious01	0.01878	0.01878
nzdep2001	-0.01788	0.01788
unpaid_acty_count01	0.01702	0.01702
ttl_personal_income06	0.01663	0.01663
Mao06	-0.01612	0.01612
live_with_siblings06	0.01417	0.01417
live_with_flatmates01	-0.014	0.014
unpaid_acty_count06	0.01307	0.01307
work_labour_force_status(	0.01171	0.01171
difficulty_acty_count01	-0.01148	0.01148
live_with_children06	0.01114	0.01114
hrs_work_mainjob06	-0.01075	0.01075
travel_work01	0.01073	0.01073
ttl_personal_income01	0.01052	0.01052
iwi_count06	-0.01006	0.01006

iwi_ind01	0.00777	0.00777
Language_count06	-0.00767	0.00767
live_alone06	0.00659	0.00659
disability_ind06	-0.00658	0.00658
live_alone01	0.00641	0.00641
live_with_parents06	0.00632	0.00632
income_support06	0.00575	0.00575
adult01	-0.00567	0.00567
work_at_home01	-0.00566	0.00566
hrs_work_mainjob01	-0.0055	0.0055
iwi_count01	0.00534	0.00534
age06	0.00496	0.00496
live_with_other01	-0.00396	0.00396
EthNS2006	-0.00395	0.00395
live_with_other06	0.00394	0.00394
EthNS2001	-0.00301	0.00301
yrs_in_NZ01	-0.00268	0.00268
NZ_born01	0.00246	0.00246
disability01	-0.00233	0.00233
live_with_flatmates06	-0.00192	0.00192
Asian06	0.00176	0.00176
travel_work06	0.00156	0.00156
disability_ind01	-0.00097	0.00097
currently_separated01	0.00096	0.00096
Other01	0.00077	0.00077
MELAA06	-0.00038	0.00038
Language_count01	-0.0003	0.0003
MELAA01	0.0003	0.0003
adult06	-0.00008	0.00008