DATA5207: Major Research Project

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A research study on the predictors of domestic violence in NSW

Aim: The aim of this study was to explore the relationship between a number of economic, financial stress and family status predictors, including male unemployment, weekly income, sole parent households and its impact on domestic violence incidents in NSW.

Method:

The study used data from the Australian Census provided by the Australian Bureau of Statistics for the years 2006, 2011 and 2016. A generalised linear Poisson model was used to study the relationship male unemployment, weekly income, sole parent households and its impact on domestic violence incidents in NSW Local Government Areas (LGA's).

Results:

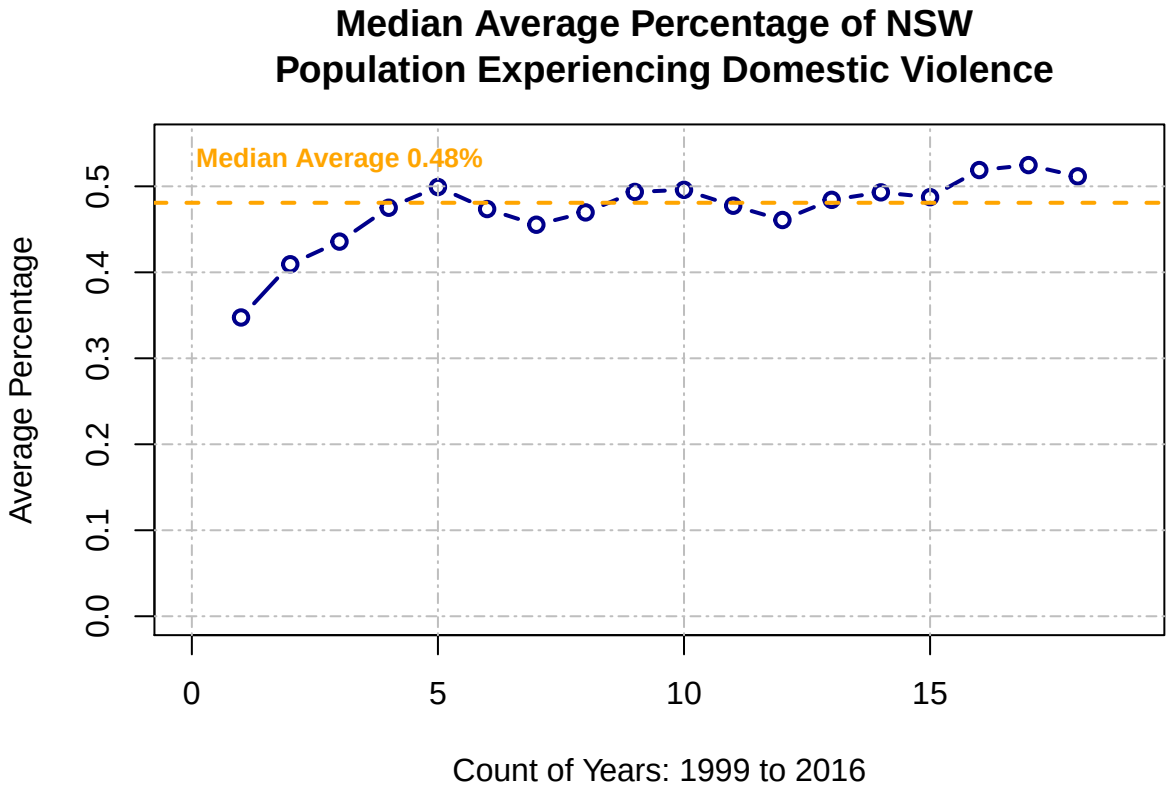
The risk of domestic violence was significantly higher for those areas where the male was unemployed, the victim is a sole parent and weekly personal income is between $800 and $1249. The results reveal twice as much ($\exp\{0.7312\} = 2.078$) risk of domestic violence incidents per 1000 people in NSW compared to those people not exposed to these factors.

Conclusion:

Economic situation, financial stress and family status predictors are strongly correlated variables for the incidents of domestic violence in NSW Local Government Areas. However, given the limitations of the data available at this level of analysis, further research would be necessary to better understand if these factors are causal or there are other confounding factors at play as a result of domestic violence events.

Introduction

Domestic violence is a major concern for Australia's local and state authorities and under the Australian Government's National Plan to Reduce Violence against Women and their Children 2010-2022, it defines domestic violence as acts of violence that occur between people who have or have had, an intimate relationship (Dunkley and Phillips, 2015, pp.1). This is further defined by The Health Costs of Violence report (2003, pp.5) as any form of intimate partner violence that can occur on a continuum of economic, psychological and emotional abuse, through physical and sexual violence. As demonstrated in the chart below levels of domestic violence in NSW have increased in frequency from 2006 to 2016 with the last three years above the median average:



Cox (2015) cites a number of risk factors with women aged 25-34 years experiencing the highest rate of male intimate domestic violence of all age groups. Furthermore, women from non-English speaking countries experienced domestic violence at double the rates compared to those from English speaking countries. Stavrou et al. (2016) cite sole parents, financial stress and those with a disability or long-term health condition as also being at risk. The latest Domestic Violence Statistics for NSW report (2013-2017) indicates alcohol was involved in almost one-third of all domestic violence incidents, while the male unemployment rate and the level of residential instability are also cited as key risk factors (People, 2005).

Data and Methodology

The study sourced data on male unemployment, weekly income and sole parents from the Australian Census provided by the Australian Bureau of Statistics for the years 2006, 2011 and 2016. Data from Census 2001 was not available from the ABS Census TableBuilder and has therefore been excluded from this study. The assumption made to compile data for the years in-between Census was populated as a percentage of the moving average growth rate from one Census date to the next. Due to the fact 2001 Census data was not available, domestic violence incidents were analysed from 2006 through to 2016. The additional year of domestic violence data was sourced from the NSW Bureau of Crime Statistics and Research (BOSCAR). Additional data from BOSCAR, in particular alcohol related domestic violence incidents, was unavailable for the required time frame and was therefore not included in the study. Estimated resident population count data was obtained from the Australian Bureau of Statistics for each year of analysis.

One issue which arose when analysing Census data from 2006 to 2016 was the change in council regions in 2016 where a number of different councils were amalgamated. To counter this, all historical data prior to 2016 was matched to the new LGA regions so the results are relevant and reproducible in the future. Refer to Appendix.

This research study and other research studies which rely on Census data are however limited by the ability to effectively understand economic and financial stress indicators, such as employment status and weekly income, making the general assumption those on lower incomes and those who are unemployed experience more financial stress than those on higher incomes or with jobs (Weatherburn, 2011). Weatherburn (2011) claims "this may be true as a rough generalisation but the level of financial stress experienced by an individual depends not just on their income but also on their financial commitments and liabilities... and is best measured in terms reflective of the gap between income and expenditure."

Considering the type of count data available and its inherent distribution characteristics a generalised linear Poisson model with a link log was the model implemented The Poisson model was considered due to the relationship between the mean and the variance and the nature of count data where the variance typically increases with the mean (Christensen, 1997). The disadvantage of a glm Poisson model is that while the linear predictor can represent any real world value, the Poisson mean, which represents a count, has to be non-negative. Given this a simple solution was to log transform the mean and assume the transformed mean follows a linear pattern. As cited by Lillis (2015) one further drawback to this model, which was experienced in this study, is that it can suffer from over-dispersion which occurs when the variance is larger than the mean in our dependent variable, or in other words, the residual variance is larger than the conditional mean. Lillis recommends the application of a Quasi-Poisson model fitting an extra dispersion parameter to account for the extra variance to confirm the over-dispersion.

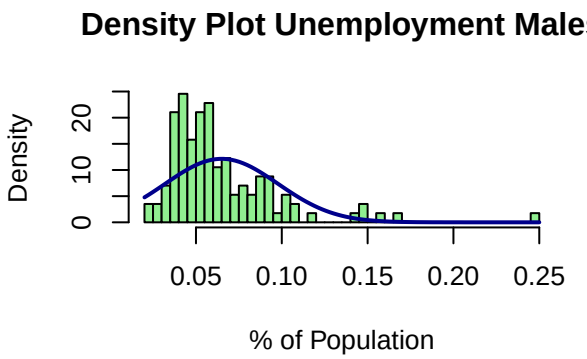
In an attempt to address this over-dispersion, a Negative Binomial Regression was the final model applied, which unlike the Poisson model, contains an extra parameter which assumes the mean and the variance are not equal. Kleiber et al.(2016) explains "as the dispersion parameter gets larger and larger, the variance converges to the same value as the mean, and the negative binomial turns into a Poisson distribution".

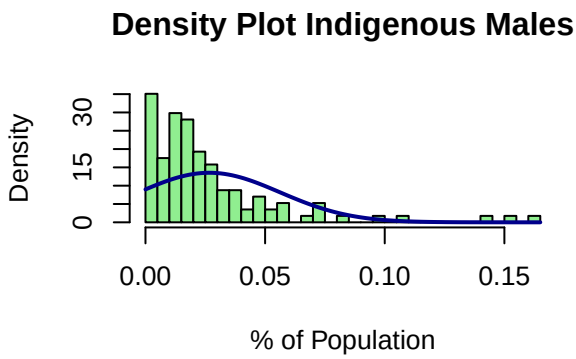
Finally, to improve the validity of the data to be integrated into the model any NSW LGA regions which had domestic violence or population counts outside of the interquartile range were excluded from the analysis and considered outliers. A total of 45 LGA regions and their data were included in the analysis.

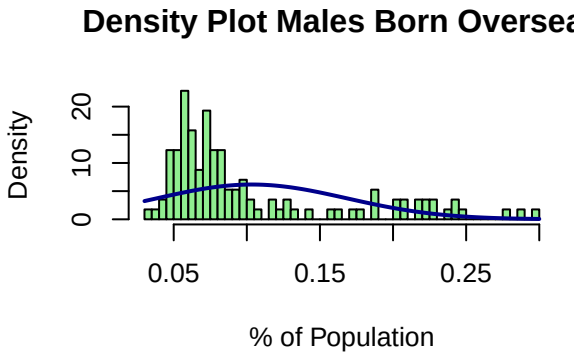
Results and Implications

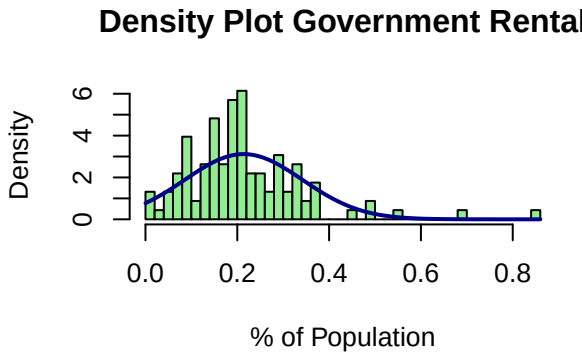
Understanding the distribution of the independent | predictor variables

After consulting numerous literacy studies as mentioned earlier in the report, a number of independent or predictor variables were considered as having a potential relationship to the dependent or outcome variable of domestic violence incidents in NSW local government areas. The first step to understanding the data was to plot the distribution of the data to understand its typical spread. Some examples of this are provided below where we can see a typical poisson type of distribution:





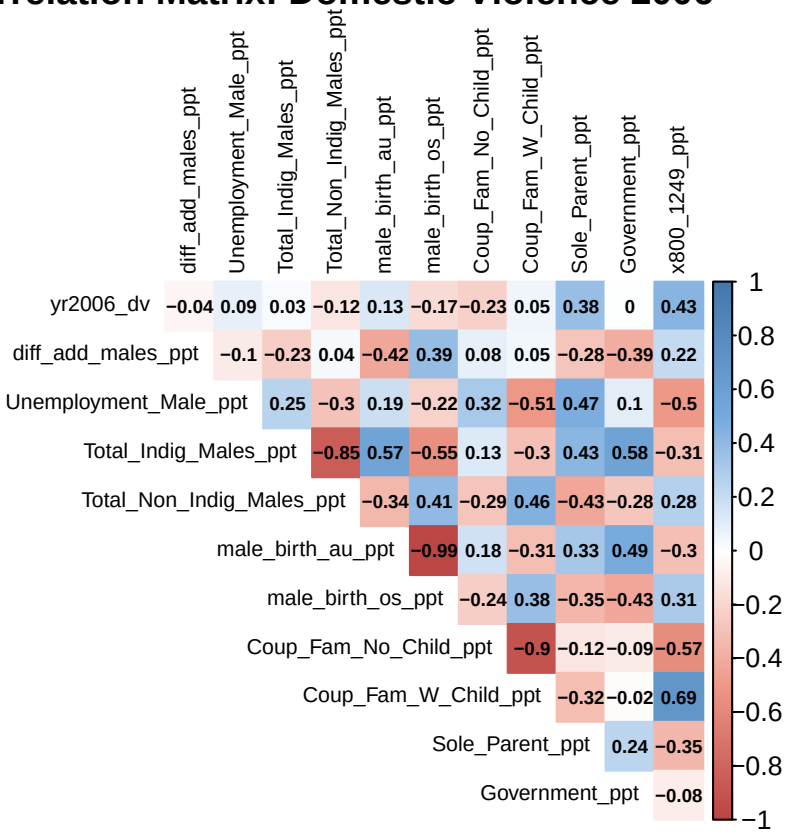




Understanding correlation between domestic violence and predictor variables

With our predictor variables combined into the one dataframe the next step of the study was to identify any possible correlation to domestic violence as well as any potential multicollinearity which may exist. Due to the possiblity of these factors changing over the time period of the domestic violence data (from 2006 to 2016) this was taken at a point in time in both years to see if there was evidence of any significant change. The two correlation matricies are shown below:

Correlation Matrix: Domestic Violence 2006

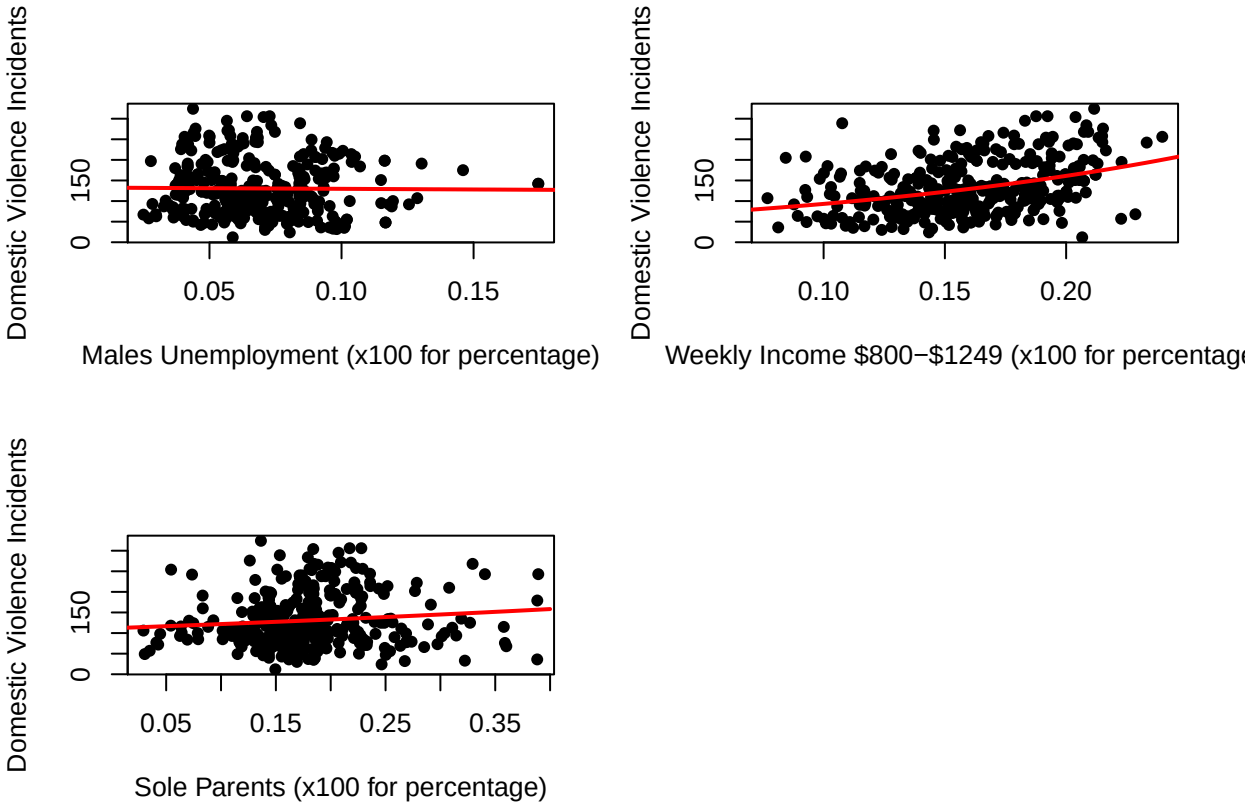


Those people earning a weekly income of between $800 and $1249 is the only factor which continued to show the highest level of correlation in both Census years (0.43). Those on Nil-to-low and higher incomes were found to show no positive correlation. Sole parents had the second highest level of correlation although this did drop from 0.38 in 2006 to 0.17 in 2016. Couples with children and Indigenous males were the only other two variables to show some movement, although minimal. Thus the key predictors brought into the model were Male Unemployment, Weekly Income between $800-$1249 and Sole Parents. Indigenous Males were not brought into the model due to the well documented fact that "there are significant deficiencies in the availability of statistics and research on the extent and nature of family violence in (Aboriginal) communities" (Bartels, 2010).

Assessing model fit and residual deviance

A 70% training set was established and randomly shuffled to ensure randomness in the selection of the data. The training data set will also allow us to train our final model against a a final testing set of data following 10 fold cross-validation to ensure our model does not over-fit the data. Using the training set data a Poisson model was created for each predictor variable in order to gain a better understanding of the effect of each predictor on the outcome variable. The output below demonstrates the effect of each of these predictor variables on domestic violence incidents with all variables having a positive relationship:

```
## Using LGA, region_id as id variables
## Using LGA, region_id as id variables
## Using LGA, region_id as id variables
## Using LGA, region_id as id variables
## Using LGA, region_id as id variables
```



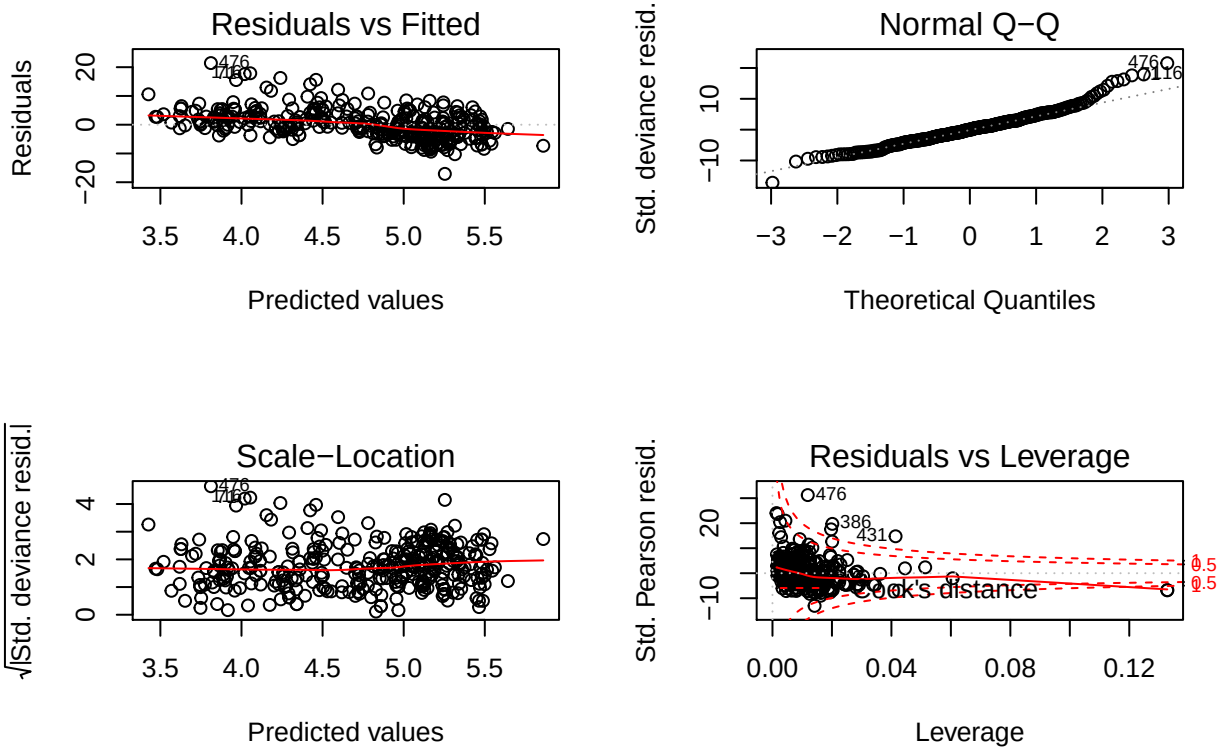
After analysing each of the predictor variables and the impact on domestic violence, all of the predictor variables are combined into the Poisson model. While each predictor variable is represented as a percentage of the population for each LGA, a population count has been implemented into the model as the offset on a per 1,000 person basis in order to control for popluation variance and reduce its impact on the model.

```
##
## Call:
## glm(formula = Domestic_Violence_Count ~ +M_Unemployment_ppt +
##     Income_x800_1249_ppt + Sole_parent_ppt + offset(log(Population_Count/1000)),
##     family = poisson(link = log), data = dataTrain)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -17.090   -3.118    0.007    2.865   21.428
##
## Coefficients:
##                       Estimate Std. Error z value Pr(>|z|)
## (Intercept)            0.52888    0.03629  14.573  < 2e-16 ***
## M_Unemployment_ppt     5.99781    0.22443  26.725  < 2e-16 ***
## Income_x800_1249_ppt   0.64537    0.16742   3.855 0.000116 ***
## Sole_parent_ppt        2.31194    0.09361  24.698  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for poisson family taken to be 1)
##
##     Null deviance: 10830.7  on 345  degrees of freedom
```

```
## Residual deviance:  8620.7  on 342  degrees of freedom
## AIC: 10907
##
## Number of Fisher Scoring iterations: 4
```

```
##           llh       llhNull            G2      McFadden          r2ML
## -5449.4121590 -6480.5385900  2062.2528620     0.1591112     0.9974208
##          r2CU
##     0.9974208
```

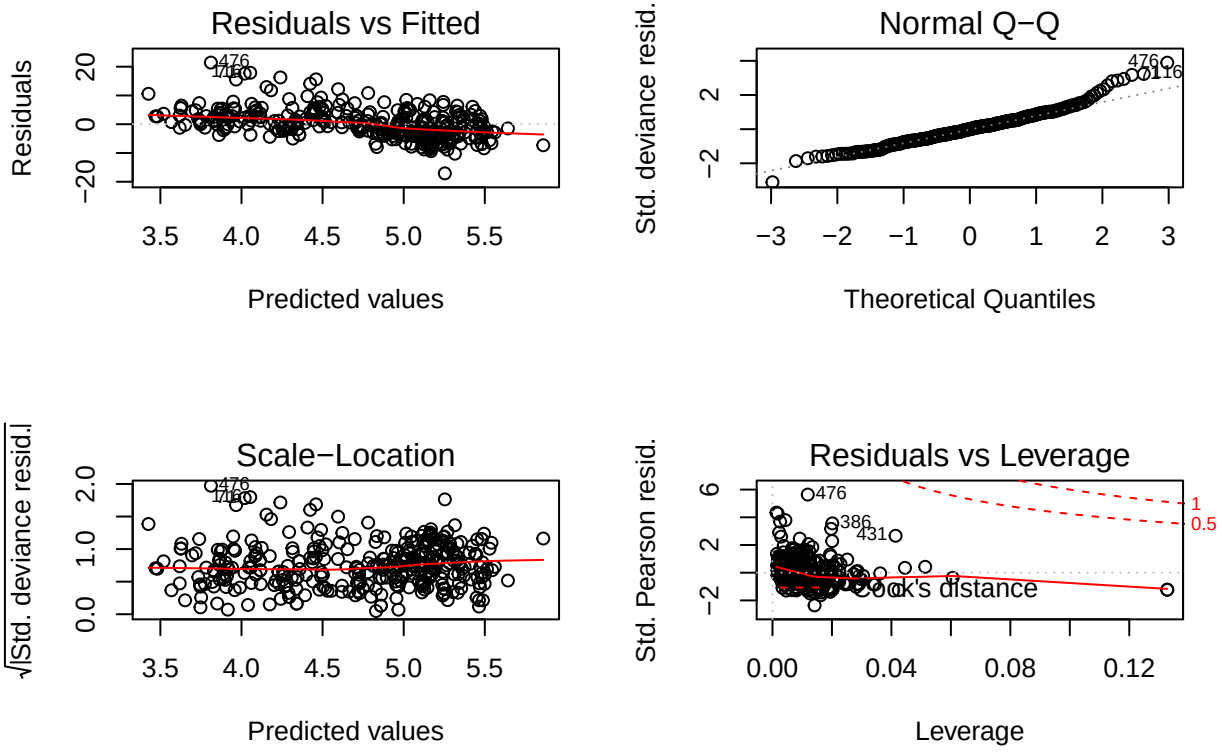
The output demonstrates for each additional male who is unemployed in NSW per 1000 people there is a 5.99 log count increase in domestic violence incidents, a 0.64 log count increase in domestic violence incidents for people with a weekly income between $800 and $1249 and a 2.31 log count increase in domestic violence incidents for sole parents. While not representing an exact equivalent to the R2 of linear regression, the McFadden R2 index can be used to assess the model fit and at 0.16 it doesn't appear to be a particularly good fit. There also appears to be possible over-dipsersion based on difference between the deviance and degrees of freedom, while the addional plots below indicate there are problems with normality and potential heterogeneity in the Poisson model.



To better understand the over-dispersion a Quasi-Poisson model was analysed with the below output:

```
##
## Call:
## glm(formula = Domestic_Violence_Count ~ +M_Unemployment_ppt +
##     Income_x800_1249_ppt + Sole_parent_ppt + offset(log(Population_Count/1000)),
##     family = quasipoisson(link = log), data = dataTrain)
##
## Deviance Residuals:
```

```
##     Min       1Q   Median       3Q      Max
## -17.090   -3.118    0.007    2.865   21.428
##
## Coefficients:
##                         Estimate Std. Error t value Pr(>|t|)
## (Intercept)               0.5289     0.2010   2.631  0.00889 **
## M_Unemployment_ppt        5.9978     1.2430   4.825 2.11e-06 ***
## Income_x800_1249_ppt      0.6454     0.9273   0.696  0.48693
## Sole_parent_ppt           2.3119     0.5185   4.459 1.12e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for quasipoisson family taken to be 30.67796)
##
##     Null deviance: 10830.7  on 345  degrees of freedom
## Residual deviance:  8620.7  on 342  degrees of freedom
## AIC: NA
##
## Number of Fisher Scoring iterations: 4
```

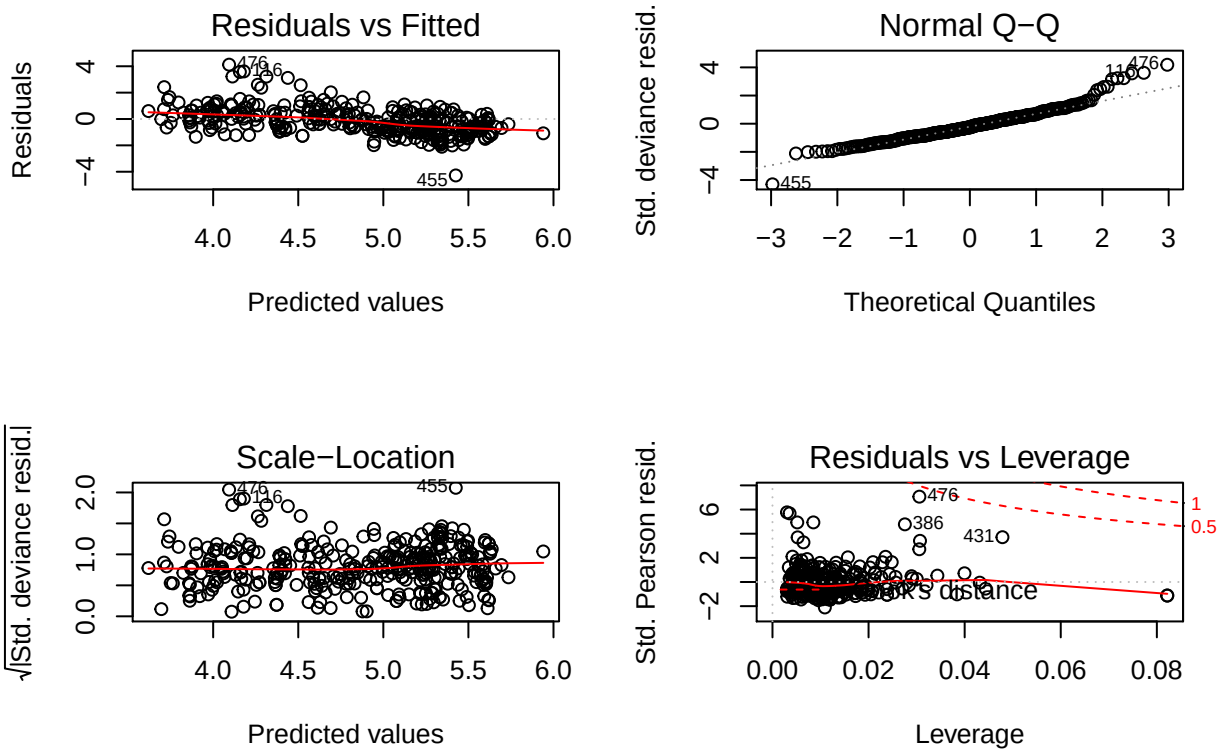


The dispersion parameter (deviance divided by the residual degrees of freedom) was 30.7, which is much greater than 1, indicating over-dispersion. In an attempt to deal with this phenomena a Negative Binomial regression model was selected, but unlike the Poisson model, the variance and the mean are not equivalent indicating it may better represent modeling counts with variability that is different from the mean.

```
##
## Call:
```

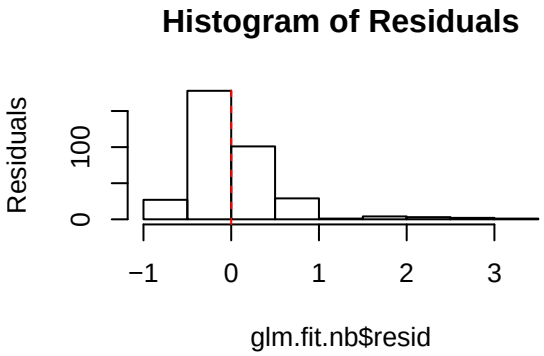
```
## glm.nb(formula = Domestic_Violence_Count ~ +M_Unemployment_ppt +
##     Income_x800_1249_ppt + Sole_parent_ppt + offset(log(Population_Count/1000)),
##     data = dataTrain, init.theta = 5.007049548, link = log)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -4.2815  -0.8286  -0.2539   0.3985   4.1204
##
## Coefficients:
##                       Estimate Std. Error z value Pr(>|z|)
## (Intercept)             0.7312     0.1831   3.994 6.49e-05 ***
## M_Unemployment_ppt      6.2625     1.2219   5.125 2.97e-07 ***
## Income_x800_1249_ppt    1.2128     0.8536   1.421  0.15535
## Sole_parent_ppt         1.2230     0.4436   2.757  0.00584 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for Negative Binomial(5.007) family taken to be 1)
##
##     Null deviance: 402.22  on 345  degrees of freedom
## Residual deviance: 357.72  on 342  degrees of freedom
## AIC: 3757.9
##
## Number of Fisher Scoring iterations: 1
##
##
##               Theta:  5.007
##           Std. Err.:  0.386
##
##  2 x log-likelihood:  -3747.945
```

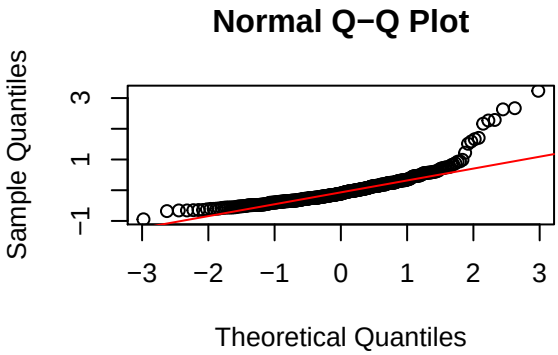
The output indicates that for each one count increase in Male Unemployment, Weekly Income and Sole Parents per 1,000 people in NSW LGA's, the expected log count of the number of domestic violence incidents increases by 6.2625, 1.2128 and 1.2230, respectively. All predictors are significant at a pvalue level of at least 0.01 except for Income at 0.15 while the overall standard error is 0.386. The Negative Binomial Distribution model has addressed the over-dispersion issue with much closer deviance and degrees of freedom indicators while the plots below indicate a reasonable assumption of normality (upper right) but the plot of the fitted versus residuals (upper left) seems to demonstrate more variation at mid-to-higher level values compared with the low fitted values.

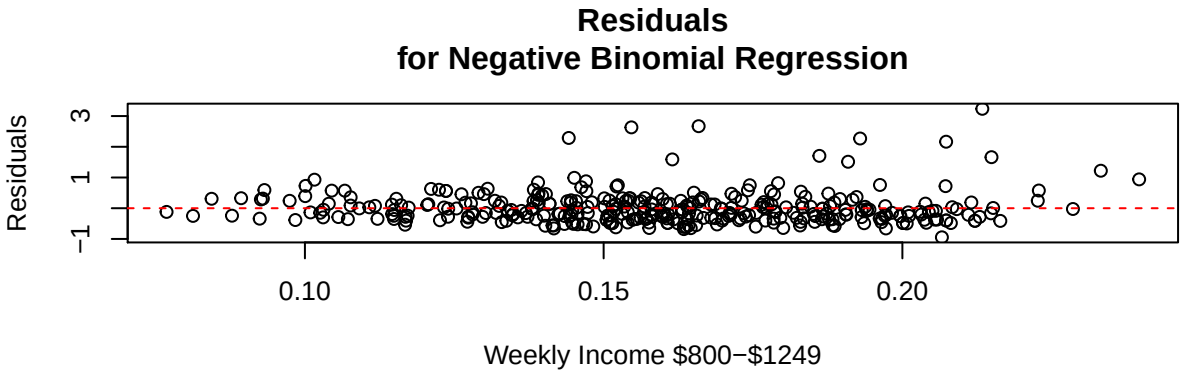


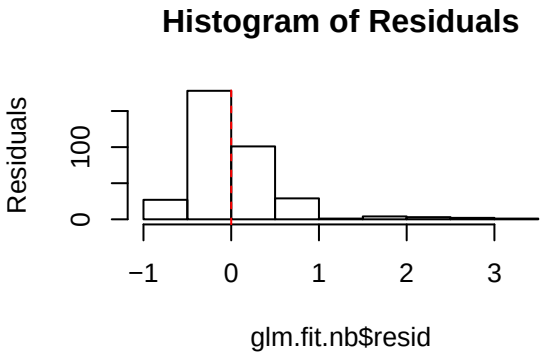
The below charts further demonstrate the Negative Binomial residuals for each of the predictor variables indicating some outliers are impacting the performance of the model:

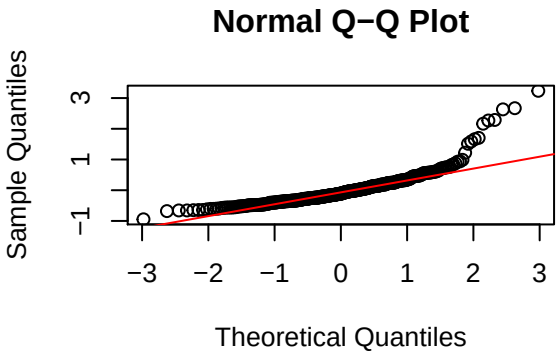

Residuals
for Negative Binomial Regression
Residuals
3
1
−1
0.05
0.10
0.15
Males Unemployment

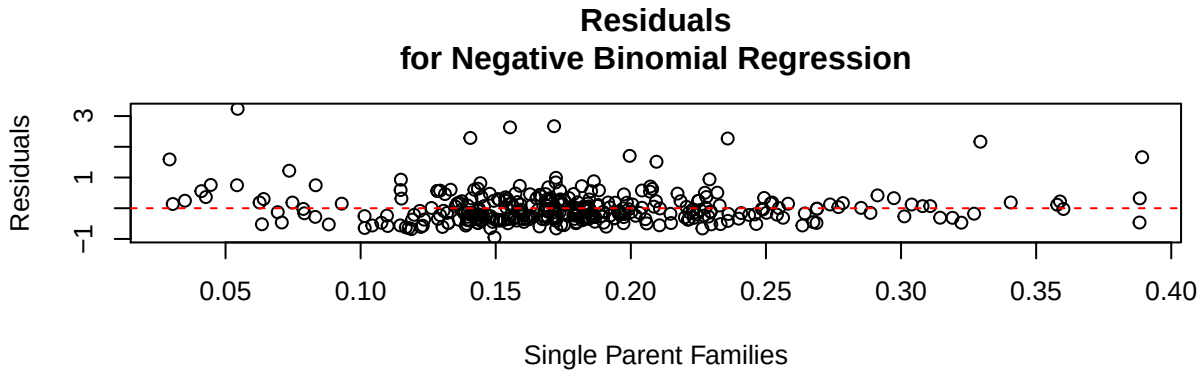

Histogram of Residuals
Residuals
100
0
−1
0
1
2
3
glm.fit.nb$resid

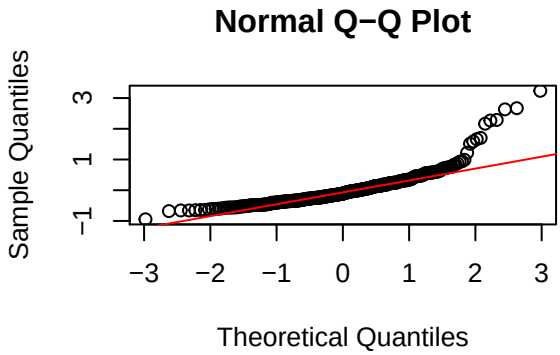

Normal Q−Q Plot
Sample Quantiles
3
1
−1
−3
−2
−1
0
1
2
3
Theoretical Quantiles


Residuals
for Negative Binomial Regression
Residuals
3
1
−1
0.10
0.15
0.20
Weekly Income $800−$1249


Histogram of Residuals
Residuals
100
0
−1
0
1
2
3
glm.fit.nb$resid


Normal Q−Q Plot
Sample Quantiles
3
1
−1
−3
−2
−1
0
1
2
3
Theoretical Quantiles





Assessing the predictive ability of the model

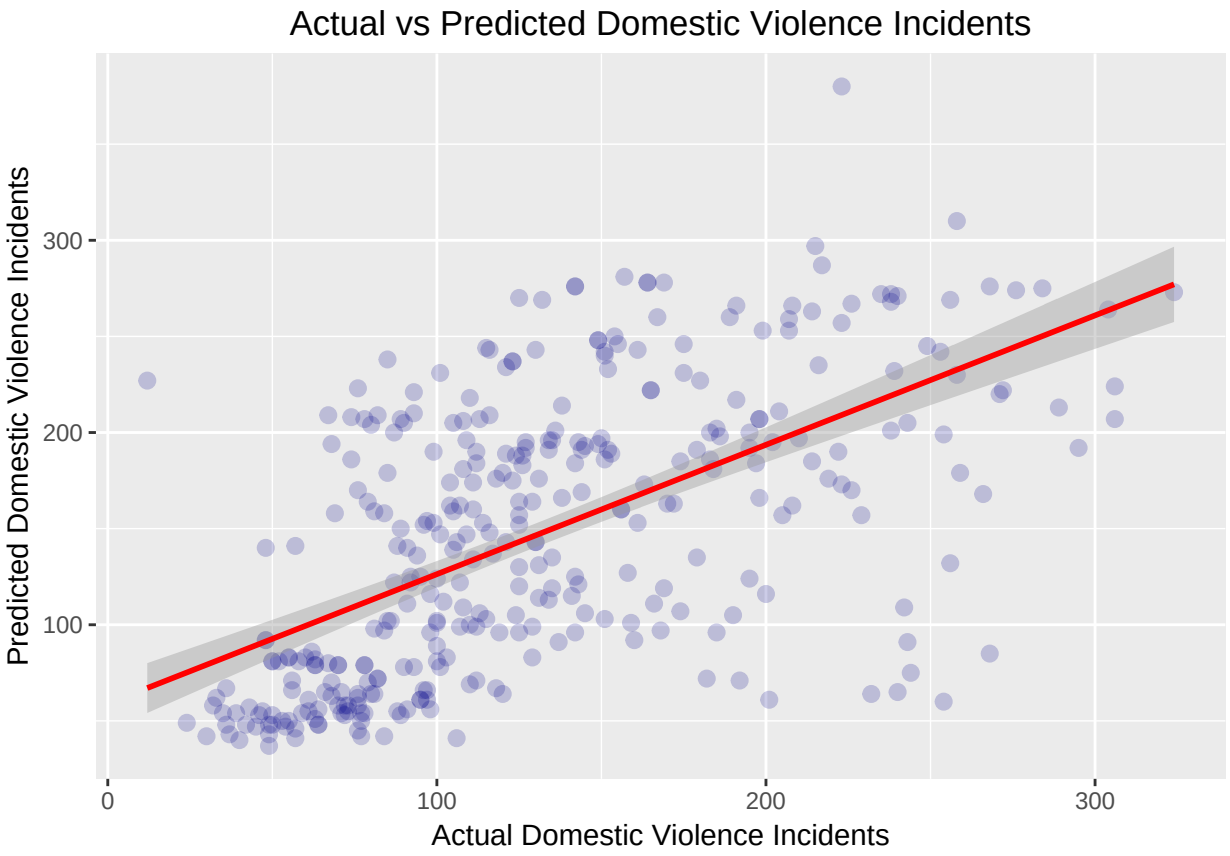
A 10 fold cross-validation was performed on the training set to avoid over-fitting the model on the final testing data set. A sample of the predicted domestic violence count rates versus the actual count rates are shown below (refer to Appendix.1 for all results) and when applied over the testing data set the prediction accuracy of the model has a mean difference of 25.6% and a median difference of 12.9% indicating some large variance in the predictions.

```
##                                 LGA Domestic_Violence_Count Pred Diff
## 474                    Lithgow (C)                      85  102   17
## 488                Wollondilly (A)                     185  202   17
## 317                    Ballina (A)                     136  201   65
## 495 Queanbeyan-Palerang Regional (A)                   161  243   82
## 16                     Griffith (C)                    142   96  -46
## 451                      Albury (C)                    284  275   -9
## 104           Glen Innes Severn (A)                     40   40    0
## 52                      Burwood (A)                     69  158   89
## 425                     Kempsey (A)                    243  205  -38
## 40            Armidale Regional (A)                    130  143   13
```

```
## [1] 25.6
```

```
## [1] 12.9
```

Finally, a plot of the actual and predicted domestic violence counts on the testing data set is shown on the scatter plot below indicating a positive relationship.



Conclusion

The study has revealed there is a significant positive relationship between domestic violence in NSW and Male Unemployment, Weekly Income of $800-$1249 and Sole Parents with the results indicating these predictors lead to twice the levels of domestic violence incidents per 1,000 people of the NSW population. The Poisson model returned an over-dispersed result which resulted in a Negative Binomial Regression model being applied as the final model. It delivered an improved model but one which demonstrated some degree of variation at mid-to-higher level values compared with lower fitted values. While the data from Census used for this study is quite limited in its application, it is nevertheless recommended for further improvement to this model with an alternative such as a generalised linear mixed model which would allow for "the inclusion of random effects in the linear predictor reflecting the idea that there is natural heterogeneity across clusters in regression coefficients" (Szyszkowicz, 2006).

References

Census Table Builder, https://auth.censusdata.abs.gov.au/webapi/jsf/dataCatalogueExplorer.xhtml

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Stavrou, E, Poynton, S & Weatherburn, S. November 2016, Intimate partner violence against women in Australia: related factors and help-seeking behaviours, NSW Bureau of Crime Statistics and Research.

Szyszkowicz, M. 2006, Use of Generalised Linear Mixed Models to Examine the Association Between Air Pollution and Health Outcomes, International Journal of Occupational Medicine and Environmental Health, 19(4):224-7.

Weatherburn, D (2011), Personal Stress, financial stress and violence against women, Contemporary Issues in Crime and Justice, NSW Bureau of Crime Statistics and Research, Number 151.

Appendix.1

	LGA	Domestic_Violence_Count	Pred	Diff
143	Byron (A)	111	174	63
390	North Sydney (A)	130	243	113
202	Leeton (A)	54	47	-7
435	North Sydney (A)	116	243	127
462	Eurobodalla (A)	142	184	42
23	Lismore (C)	289	213	-76
259	Singleton (A)	67	80	13
436	Orange (C)	306	224	-82
269	Queanbeyan-Palerang Regional (A)	199	253	54
222	Snowy Valleys (A)	48	92	44
465	Goulburn Mulwaree (A)	105	139	34
220	Armidale Regional (A)	142	276	134
328	Forbes (A)	64	48	-16
277	Burwood (A)	76	170	94
50	Botany Bay (C)	161	153	-8
432	Muswellbrook (A)	92	125	33
118	Nambucca (A)	92	122	30
21	Kyogle (A)	36	48	12
157	Leeton (A)	50	48	-2
455	Botany Bay (C)	12	227	215
423	Hawkesbury (C)	276	274	-2
329	Glen Innes Severn (A)	24	49	25
303	Richmond Valley (A)	158	127	-31
470	Kempsey (A)	229	157	-72
309	Woollahra (A)	74	208	134
334	Inverell (A)	137	91	-46
256	Orange (C)	266	168	-98
279	Camden (A)	151	240	89
136	Albury (C)	239	232	-7
69	Lithgow (C)	110	100	-10
448	Snowy Valleys (A)	78	79	1
419	Glen Innes Severn (A)	76	62	-14
320	Botany Bay (C)	105	205	100
368	Byron (A)	135	196	61
12	Eurobodalla (A)	127	192	65
484	Singleton (A)	84	97	13

```
## 349                    Singleton (A)                    81   98   17
## 100              Clarence Valley (A)                   167  260   93
## 146                         Cowra (A)                    88   55  -33
## 106                      Griffith (C)                   129   99  -30
## 65                        Kempsey (A)                   208  162  -46
## 189                       Camden (A)                   180  227   47
## 188                        Byron (A)                    99  190   91
## 167                       Parkes (A)                    96   66  -30
## 466                      Griffith (C)                   242  109 -133
## 63                     Hawkesbury (C)                   238  268   30
## 105            Goulburn Mulwaree (A)                   135  119  -16
## 209                      Narrabri (A)                    70   58  -12
## 119                      Narrabri (A)                    76   58  -18
## 383                       Lismore (C)                   214  263   49
## 478                      Nambucca (A)                   100  102    2
## 197                      Gunnedah (A)                    71   54  -17
## 354                     Woollahra (A)                    78  207  129
## 54                        Camden (A)                   116  209   93
## 248                       Lismore (C)                   207  253   46
## 91                         Albury (C)                   258  230  -28
## 56                          Cowra (A)                    59   54   -5
## 330            Goulburn Mulwaree (A)                   101  147   46
## 392                       Parkes (A)                   100   89  -11
## 164                      Narrabri (A)                    72   58  -14
## 290                       Kempsey (A)                   214  185  -29
## 42                  Snowy Valleys (A)                    95   61  -34
## 452                       Ballina (A)                   109  196   87
## 447                 Snowy Valleys (A)                    78   79    1
## 352                 Wingecarribee (A)                   124  188   64
## 193                       Forbes (A)                    84   42  -42
## 348              Richmond Valley (A)                   135  135    0
## 429                      Lithgow (C)                    94  136   42
## 340         Mid-Western Regional (A)                    91  111   20
## 453            Bathurst Regional (A)                   186  198   12
## 321                  Broken Hill (C)                   169  119  -50
## 267                 Snowy Valleys (A)                    55   83   28
## 301                       Orange (C)                   259  179  -80
## 1                          Albury (C)                   271  220  -51
## 201                       Kyogle (A)                    39   54   15
## 93             Bathurst Regional (A)                   226  170  -56
## 160         Mid-Western Regional (A)                    98   96   -2
## 257                       Parkes (A)                   120   64  -56
## 147                  Eurobodalla (A)                   152  191   39
## 47                        Ballina (A)                   183  186    3
## 102                  Eurobodalla (A)                   144  191   47
## 482                       Parkes (A)                   118   67  -51
## 173                 Wollondilly (A)                   144  169   25
## 325              Clarence Valley (A)                   217  287   70
## 43                 Snowy Valleys (A)                    95   61  -34
## 179 Queanbeyan-Palerang Regional (A)                   155  246   91
## 403                 Snowy Valleys (A)                    70   79    9
## 365                    Botany Bay (C)                   110  218  108
## 361                        Albury (C)                   304  264  -40
## 72                  Muswellbrook (A)                    68   63   -5
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## 53                          Byron (A)    89  150   61
## 264                      Woollahra (A)    67  209  142
## 139                    Bega Valley (A)   109  147   38
## 265              Armidale Regional (A)   175  231   56
## 129                      Woollahra (A)    87  200  113
## 76                          Orange (C)   170  163   -7
## 313                  Snowy Valleys (A)    52   81   29
## 38                     Wollondilly (A)   129  164   35
## 186                    Broken Hill (C)   166  111  -55
## 203                        Lismore (C)   207  259   52
## 237                    Eurobodalla (A)   153  189   36
## 132                  Snowy Valleys (A)    82   72  -10
## 430          Mid-Western Regional (A)   125  130    5
## 375              Goulburn Mulwaree (A)   125  157   32
## 454                    Bega Valley (A)   106  143   37
## 428                        Lismore (C)   208  266   58
## 356              Armidale Regional (A)   198  207    9
## 395                    Strathfield (A)   113  207   94
## 159                        Lithgow (C)   100  101    1
## 57                     Eurobodalla (A)   134  191   57
## 407                        Ballina (A)    93  210  117
## 116                   Moree Plains (A)   240   65 -175
## 24                         Lithgow (C)   107   99   -8
## 363              Bathurst Regional (A)   238  201  -37
## 275                    Botany Bay (C)   143  195   52
## 55                 Clarence Valley (A)   154  250   96
## 485                    Strathfield (A)   108  206   98
## 385          Mid-Western Regional (A)   125  120   -5
## 221              Armidale Regional (A)   142  276  134
## 153                     Hawkesbury (C)   256  269   13
## 243                     Hawkesbury (C)   235  272   37
## 120                  North Sydney (A)   101  231  130
## 115          Mid-Western Regional (A)   125   96  -29
## 82                  Wingecarribee (A)   131  176   45
## 138              Bathurst Regional (A)   223  173  -50
## 408              Bathurst Regional (A)   204  211    7
## 386                   Moree Plains (A)   268   85 -183
## 34                       Singleton (A)    62   86   24
## 405 Queanbeyan-Palerang Regional (A)   123  237  114
## 253                      Nambucca (A)    87  122   35
## 227                        Ballina (A)   149  194   45
## 412                        Burwood (A)    76  223  147
## 245                        Kempsey (A)   184  181   -3
## 424                       Inverell (A)   113  106   -7
## 391                         Orange (C)   306  207  -99
## 238                         Forbes (A)    77   42  -35
## 296                   Moree Plains (A)   244   75 -169
## 282                    Eurobodalla (A)   179  191   12
## 350                    Strathfield (A)   121  189   68
## 477                  Muswellbrook (A)    93   78  -15
## 111                         Kyogle (A)    63   51  -12
## 145                Clarence Valley (A)   125  270  145
## 4                      Bega Valley (A)   117  137   20
## 476                   Moree Plains (A)   254   60 -194
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## 359 Queanbeyan-Palerang Regional (A)  151  242   91
## 81             Warrumbungle Shire (A)   64   48  -16
## 84                      Woollahra (A)   68  194  126
## 27                   Muswellbrook (A)   76   64  -12
## 86              Armidale Regional (A)  156  160    4
## 254                     Narrabri (A)   43   57   14
## 293                      Lismore (C)  223  257   34
## 172                 Wingecarribee (A)  120  179   59
## 134 Queanbeyan-Palerang Regional (A)  165  222   57
## 85              Armidale Regional (A)  156  160    4
## 398                   Wollondilly (A)  145  193   48
## 133                 Snowy Valleys (A)   82   72  -10
## 194             Glen Innes Severn (A)   37   43    6
## 74                      Narrabri (A)   97   61  -36
## 150             Goulburn Mulwaree (A)  142  125  -17
## 338                      Lismore (C)  189  260   71
## 169                    Singleton (A)   63   82   19
## 480                  North Sydney (A)  132  269  137
## 217                 Wingecarribee (A)  108  181   73
## 125                   Strathfield (A)   99  153   54
## 479                      Narrabri (A)   98   56  -42
## 177                 Snowy Valleys (A)   50   81   31
## 244                      Inverell (A)  100   81  -19
## 73                       Nambucca (A)  107  122   15
## 135 Queanbeyan-Palerang Regional (A)  165  222   57
## 87                  Snowy Valleys (A)   56   66   10
## 205         Mid-Western Regional (A)  119   96  -23
## 60              Goulburn Mulwaree (A)  141  115  -26
## 468                    Hawkesbury (C)  258  310   52
## 241                      Griffith (C)  190  105  -85
## 215                   Strathfield (A)  107  162   55
## 198                    Hawkesbury (C)  240  271   31
## 472                         Leeton (A)   57   46  -11
## 335                       Kempsey (A)  222  190  -32
## 278                         Byron (A)  126  183   57
## 184                  Bega Valley (A)   96  152   56
## 402                 Snowy Valleys (A)   70   79    9
## 99                         Camden (A)  138  214   76
## 486           Warrumbungle Shire (A)   49   43   -6
## 83                    Wollondilly (A)  125  164   39
## 185                   Botany Bay (C)  126  188   62
## 337                         Leeton (A)   47   55    8
## 372                  Eurobodalla (A)  134  196   62
## 174                    Woollahra (A)   80  204  124
## 281                         Cowra (A)   73   58  -15
## 276                  Broken Hill (C)  134  113  -21
## 459                         Camden (A)  223  380  157
## 98                          Byron (A)  111  160   49
## 299                      Narrabri (A)   61   61    0
## 426                        Kyogle (A)   36   67   31
## 283                        Forbes (A)   76   45  -31
## 140                   Botany Bay (C)  118  176   58
## 122                        Parkes (A)   97   66  -31
## 444                    Woollahra (A)   90  205  115
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## 46                        Albury (C)                272  222  -50
## 170                  Strathfield (A)                 81  159   78
## 71                  Moree Plains (A)                232   64 -168
## 475         Mid-Western Regional (A)                124  105  -19
## 438              Richmond Valley (A)                125  152   27
## 151                       Griffith (C)               151  103  -48
## 331                       Griffith (C)               200  116  -84
## 469                       Inverell (A)               101   78  -23
## 456                   Broken Hill (C)                160   92  -68
## 305                  Strathfield (A)                 104  174   70
## 49                    Bega Valley (A)                 91  140   49
## 481                       Orange (C)                 254  199  -55
## 371                        Cowra (A)                  71   65   -6
## 406                       Albury (C)                 268  276    8
## 62                       Gunnedah (A)                 61   55   -6
## 191                        Cowra (A)                  91   56  -35
## 14             Glen Innes Severn (A)                  49   37  -12
## 298                       Nambucca (A)                95  125   30
## 314 Queanbeyan-Palerang Regional (A)                149  248   99
## 114                        Lithgow (C)                112   99  -13
## 228            Bathurst Regional (A)                219  176  -43
## 346                       Orange (C)                 295  192 -103
## 78               Richmond Valley (A)                  185   96  -89
## 404 Queanbeyan-Palerang Regional (A)                123  237  114
## 199                       Inverell (A)               129   83  -46
## 187                        Burwood (A)               105  159   54
## 15             Goulburn Mulwaree (A)                102  112   10
## 107                      Gunnedah (A)                 78   54  -24
## 401            Armidale Regional (A)                195  200    5
## 292                         Leeton (A)                 53   50   -3
## 272                        Ballina (A)                150  197   47
## 474                       Lithgow (C)                 85  102   17
## 488                  Wollondilly (A)                 185  202   17
## 317                        Ballina (A)                136  201   65
## 495 Queanbeyan-Palerang Regional (A)                161  243   82
## 16                        Griffith (C)               142   96  -46
## 451                       Albury (C)                 284  275   -9
## 104            Glen Innes Severn (A)                  40   40    0
## 52                         Burwood (A)                69  158   89
## 425                       Kempsey (A)                243  205  -38
## 40             Armidale Regional (A)                130  143   13
## 206                 Moree Plains (A)                182   72 -110
## 300                 North Sydney (A)                115  244  129
## 318            Bathurst Regional (A)                195  192   -3
## 44  Queanbeyan-Palerang Regional (A)                197  184  -13
## 464            Glen Innes Severn (A)                106   41  -65
## 79                    Singleton (A)                  60   83   23
## 182                        Ballina (A)                127  195   68
## 458                          Byron (A)                 97  154   57
## 322                        Burwood (A)                74  186  112
## 239            Glen Innes Severn (A)                  30   42   12
## 410                  Botany Bay (C)                 121  234  113
## 64                        Inverell (A)               112   71  -41
## 380                       Kempsey (A)                210  197  -13
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## 443                  Wollondilly (A)  183  200   17
## 431                 Moree Plains (A)  243   91 -152
## 128                  Wollondilly (A)  138  166   28
## 378                   Hawkesbury (C)  324  273  -51
## 41              Armidale Regional (A)  130  143   13
## 97                        Burwood (A)   79  164   85
## 112                       Leeton (A)   42   48    6
## 364                  Bega Valley (A)   84  158   74
## 218                  Wollondilly (A)  163  173   10
## 207                 Muswellbrook (A)   80   64  -16
## 158                       Lismore (C)  249  245   -4
## 377                      Gunnedah (A)   66   65   -1
## 374             Glen Innes Severn (A)   73   55  -18
## 427                       Leeton (A)   68   70    2
## 381                       Kyogle (A)   33   62   29
## 80                    Strathfield (A)   57  141   84
## 5                      Botany Bay (C)  116  148   32
## 274                  Bega Valley (A)  114  153   39
## 196                     Griffith (C)  145  106  -39
## 2                        Ballina (A)  174  185   11
## 17                       Gunnedah (A)   64   56   -8
## 37                  Wingecarribee (A)  123  175   52
## 171            Warrumbungle Shire (A)   45   47    2
## 162                 Muswellbrook (A)   81   64  -17
## 213               Richmond Valley (A)  111  134   23
## 415               Clarence Valley (A)  215  297   82
## 223                 Snowy Valleys (A)   48   92   44
## 141                   Broken Hill (C)  174  107  -67
## 315 Queanbeyan-Palerang Regional (A)  149  248   99
## 30                    North Sydney (A)   93  221  128
## 342                 Muswellbrook (A)  103   83  -20
## 48              Bathurst Regional (A)  198  166  -32
## 13                          Forbes (A)   57   41  -16
## 288                   Hawkesbury (C)  238  272   34
## 307                 Wingecarribee (A)  112  184   72
## 416                         Cowra (A)   79   70   -9
## 461                         Cowra (A)   72   53  -19
## 409                  Bega Valley (A)  104  162   58
## 294                       Lithgow (C)  108  109    1
## 445             Armidale Regional (A)  202  195   -7
## 271                         Albury (C)  253  242  -11
## 178                 Snowy Valleys (A)   50   81   31
## 152                       Gunnedah (A)   77   54  -23
## 258               Richmond Valley (A)  143  121  -22
## 225 Queanbeyan-Palerang Regional (A)  164  278  114
## 204                       Lithgow (C)   86  102   16
## 20                        Kempsey (A)  205  157  -48
## 389                       Narrabri (A)   56   71   15
## 376                       Griffith (C)  195  124  -71
## 224 Queanbeyan-Palerang Regional (A)  164  278  114
## 268                 Snowy Valleys (A)   55   83   28
## 216            Warrumbungle Shire (A)   49   48   -1
## 121                          Orange (C)  172  163   -9
## 92                        Ballina (A)  112  190   78
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## 214                    Singleton (A)                    58   81   23
## 339                      Lithgow (C)                    98  116   18
## 219                    Woollahra (A)                    82  209  127
## 190               Clarence Valley (A)                   157  281  124
## 483               Richmond Valley (A)                   131  114  -17
## 347                        Parkes (A)                    90   78  -12
## 131             Armidale Regional (A)                   151  186   35
## 11                          Cowra (A)                    46   53    7
## 242                     Gunnedah (A)                     89   53  -36
## 437                        Parkes (A)                   115  103  -12
## 310             Armidale Regional (A)                   191  217   26
## 411                   Broken Hill (C)                   179  135  -44
## 450 Queanbeyan-Palerang Regional (A)                    152  233   81
## 393               Richmond Valley (A)                   121  143   22
## 246                        Kyogle (A)                    35   54   19
## 489                     Woollahra (A)                    89  207  118
## 26                   Moree Plains (A)                   201   61 -140
## 473                       Lismore (C)                   175  246   71
## 18                     Hawkesbury (C)                   226  267   41
## 6                     Broken Hill (C)                   168   97  -71
## 306            Warrumbungle Shire (A)                    55   50   -5
## 351            Warrumbungle Shire (A)                    50   53    3
## 369                        Camden (A)                   191  266   75
## 421                     Griffith (C)                    256  132 -124
## 235               Clarence Valley (A)                   169  278  109
## 208                     Nambucca (A)                    100  124   24
## 358                  Snowy Valleys (A)                   63   79   16
## 467                       Gunnedah (A)                   77   50  -27
## 51                    Broken Hill (C)                   159  101  -58
## 251                  Moree Plains (A)                   192   71 -121
## 355             Armidale Regional (A)                   198  207    9
## 165                  North Sydney (A)                    85  238  153
## 233                          Byron (A)                   85  179   94
## 195             Goulburn Mulwaree (A)                   131  131    0
## 181                        Albury (C)                    216  235   19
## 19                       Inverell (A)                   110   69  -41
## 357                  Snowy Valleys (A)                   63   79   16
## 35                     Strathfield (A)                   48  140   92
## 336                        Kyogle (A)                    32   58   26
## 439                     Singleton (A)                    88  141   53
```

Appendix.2

Canterbury-Bankstown (A) The Canterbury-Bankstown Council is a local government area located in the south-western suburbs of Sydney, in New South Wales, Australia. The council was formed on 12 May 2016 from a merger of the City of Canterbury and the City of Bankstown, after a review of local government in New South Wales by the state government. Source: Canterbury-Bankstown Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 14 May 2016.

Snowy Monaro Regional (A) The Snowy Monaro Regional Council is a local government area located in the Snowy Mountains and Monaro regions of New South Wales, Australia. The council was formed on 12 May 2016 through a merger of the Bombala, Cooma-Monaro and Snowy River shires. Source: Snowy Monaro Regional Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 13 May 2016.

Hilltops (A) Hilltops Council is a local government area in the South West Slopes region of New South Wales, Australia. This area was formed on the 12 May 2016 from the merger of Boorowa Council, Harden Shire and Young Shire. Source: Hilltops Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 14 May 2016.

Central Coast (C) (NSW) The Central Coast Council is a local government area serving the Central Coast region of New South Wales, Australia, established on 12 May 2016 following the amalgamation of Gosford City and Wyong Shire councils. Source: Central Coast Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 14 May 2016.

Edward River (A) The Edward River Council is a local government area in the Riverina region of New South Wales, Australia. This area was formed in 2016 from the merger of the Deniliquin Council with the surrounding Conargo Shire. Source: Edward River Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 13 May 2016.

Federation (A) A 2015 review of local government boundaries by the NSW Government Independent Pricing and Regulatory Tribunal recommended that the Corowa Shire merge with the Lockhart and Urana shires to form a new council with an area of 8,581 square kilometres (3,313 sq mi) and support a population of approximately 16,000.[3] The Council was dissolved on 12 May 2016 and along with Urana Shire the area became part of the new Federation Council. Source: Federation Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 13 May 2016.

Western Plains Regional (A) The Dubbo Regional Council is a local government area located in the Central West and Orana regions of New South Wales, Australia. The council was formed on 12 May 2016 through a merger of the City of Dubbo and Wellington Council. Source: Dubbo Regional Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 7 January 2016.

Cumberland (A) The Cumberland Council is a local government area located in the western suburbs of Sydney in the state of New South Wales, Australia. The Council was formed on 12 May 2016 from the merger of parts of the Auburn City, the former Parramatta City (Woodville Ward), and Holroyd City councils.[2][3] Source: Cumberland Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 13 May 2016. Local Government (City of Parramatta and Cumberland) Proclamation 2016 [NSW] - Schedule 2 - Provisions for Cumberland Council. NSW Government. 12 May 2016. Retrieved 29 September 2017.

Georges River (A) The Georges River Council is a local government area located in the St George region of Sydney located south of the CBD, in New South Wales, Australia. The Council was formed on 12 May 2016 from the merger of the Kogarah City Council and Hurstville City Council.[3]

Mid-Coast (A) Mid-Coast Council is a local government area located in the Mid North Coast region of New South Wales, Australia. The council was formed on 12 May 2016 through a merger of the Gloucester Shire, Great Lakes and City of Greater Taree councils.[1] Source: Mid-Coast Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 24 May 2016.

Gloucester (A) A 2015 review of local government boundaries by the NSW Government Independent Pricing and Regulatory Tribunal recommended that the Gloucester Shire merge with adjoining councils. The government considered two proposals. The first proposed a merger of Gloucester Shire and Dungog Shire councils to form a new council with an area of 5,200 square kilometres (2,000 sq mi) and support a population of approximately 14,000.[6] Following the lodging of an alternate proposal by Gloucester Shire Council to amalgamate the Gloucester, Great Lakes and Greater Taree councils, the NSW Minister for Local Government proposed a merger between the Dungog Shire and City of Maitland. Source: Mid-Coast Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 20 May 2016.

Armidale Regional (A) Guyra Shire is the name of a former local government area located in the New England region of New South Wales, Australia. The shire was abolished on 12 May 2016, where the council, together with the Armidale Dumaresq Shire, was subsumed into the Armidale Regional Council with immediate effect. Source: Armidale Regional Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 12 May 2016.

Inner West (A) Inner West Council is a local government area located in the inner western region of Sydney

in the state of New South Wales, Australia. The Council was formed on 12 May 2016 from the forced merger of the Ashfield, Leichhardt, and Marrickville councils. Source: Inner West Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 15 May 2016.

Murrumbidgee (A) Jerilderie Shire was a local government area in the Riverina region of southern New South Wales, Australia. The Shire was located adjacent to the Newell Highway. The Shire was declared in 1918 after the amalgamation of the former Municipality of Jerilderie (1889 - 1918) and Wunnamurra Shire (1906 - 1918). It was dissolved in 2016 after its amalgamation with Murrumbidgee Shire to create Murrumbidgee Council. Source: Murrumbidgee Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 13 May 2016.

Northern Beaches (A) The Northern Beaches Council is a local government area located in the northern beaches region of Sydney, in the state of New South Wales, Australia. The Council was formed on 12 May 2016 replacing Manly, Pittwater and Warringah Councils. Source: Northern Beaches Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 12 May 2016.

Murray River (A) The Murray River Council is a local government area in the Riverina region of New South Wales, Australia. This area was formed in 2016 from the merger of Murray Shire with Wakool Shire. Source: Murray River Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 13 May 2016.

Snowy Valleys (A) The Snowy Valleys Council is a local government area located in the South West Slopes region of New South Wales, Australia. This area was formed in 2016 from the merger of Tumbarumba Shire and Tumut Shire councils. Source: Snowy Valley Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 13 May 2016.

Queanbeyan-Palerang Regional (A) Queanbeyan-Palerang Regional Council is a local government area located in the Southern Tablelands region of New South Wales, Australia. The council was formed on 12 May 2016 through a merger of the City of Queanbeyan and Palerang Council. Source: Queanbeyan-Palerang Regional Council. Stronger Councils. Government of New South Wales. 12 May 2016. Retrieved 21 May 2016.

Bayside Bayside Council is a local government area located around Botany Bay which is split between the eastern suburbs and St George areas of Sydney, located between 7 kilometres (4.3 mi) and 12 kilometres (7.5 mi) south of the CBD[3] in the state of New South Wales, Australia. The Council was formed on 9 September 2016 from the merger of the Botany Bay and the Rockdale councils. Source: Bayside Council. Stronger Councils. Government of New South Wales. 9 September 2016. Retrieved 9 September 2016.