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Article

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Article

Hospital Proximity and Mortality in Australia

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Abstract: It is intuitive that proximity to hospitals can only improve the chances of survival from a range of medical conditions. This study examines the empirical evidence for this assertion, based on Australian data. While hospital proximity might serve as a proxy for other factors, such as indigency, income, wealth or geography, the evidence suggests that proximity provides the most direct link to these factors. In addition, as it turns out, a very statistically significant one that transcends economies.

Keywords: hospital proximity; Australian regional mortality; heteroscedasticity

JEL Classification: I1; I11; R11

1. Introduction

The case of Australia provides an appropriate setting for a proximity study as it is very diverse in terms of hospital locations and population densities, not unlike the United States or Canada, but less densely populated than most parts of Europe or Asia. Whilst there are some studies of the effect of hospital proximity on the outcome of particular conditions (for example, the effect of hospital proximity on young road traffic victims in the UK [Bentham \(1986\)](#)), Nicholl discusses the effect of proximity based on ambulance data, and claims that age, sex and illness are not significant factors. However, that study was for the UK, where distances are much smaller than in Australia. Nonetheless, this paper is broadly consistent with those quantitative findings, allowing for the greater distances involved and the emergency of the situation.

Infant mortality [Karra et al. \(2017\)](#) has also been studied across a range of countries, which are also broadly in line with this paper. This study thus provides a quantitative first step with the general conclusion that proximity affects an increase in mortality according to region; it may provide insight into the optimum location of hospitals, and perhaps the facilities that should be provided to deal with certain conditions.

The geographic and spatial dimensions of mortality have long been recognized, particularly with respect to particular conditions such as cancer and heart disease [Haining \(2017\)](#). There are many variables that affect regional mortality, such as ethnicity, income, familiarity as well as local amenity. In such studies, the issue of heteroscedasticity in statistical models is particularly serious [Fung et al. \(2017\)](#), especially when historical analysis and forecasting are involved.

This paper adopts a simple approach by avoiding all the factors that might be incidentally associated with region. It is based on an Australian census, conducted every three years. Whilst regional data are provided as part of the survey, the only relevance to this paper is the proximity to hospitals that the population enjoys (or suffers), and not any other incidental factor that location might provide. It is possible that proximity is a proxy for income and wealth variables—which are either unavailable or inaccessible. Thus, we are not focused on mortality trends; indeed, the results of this paper highlight the pitfalls of doing so.

In summary, this paper is broadly consistent with the proximity studies cited above, given their limited scope. First, it is relevant to the planning and location of hospitals. Second, it throws a different light on insurance pricing and design.

2. Data

Data were provided by the Australian Bureau of Statistics (ABS) from the inter-census period 2005–2007 [Australian Bureau of Statistics \(2010\)](#), which was used to construct the Australian Life Tables relating to that period. Population data related to the mid-census year 2006 and mortality data to the inter-census period; these were reasonably consistent with the data published in the Australian Life Tables 2005–07 (ALT) [Australian Government Actuary \(2009\)](#). It is acknowledged that more recent data are available, but, given the difficulty in acquiring that data, this should not detract from the principles involved in this study. It should be noted that mortality relates to a three-year period, so that the mortality rates in this study need to be divided by 3 to provide annualized rates.

The statistics were subdivided by age, sex and statistical division (SD). The SD is a concept used by the ABS to denote geographical location: there are 61 SDs in total, covering all states, territories and dependencies in Australia. In this paper, the terms SD and ‘region’ are used interchangeably. The origin of SDs is purely historical and political, based on the establishment of the various Australian states and their settlement since colonization. Thus, they do not afford a truly objective basis for studying mortality, a theme to which we return in this paper.

Of the 61 SDs, mortality data were provided for only 59 SDs. No data were provided for ‘Other Territories’, which cover the outlying islands. Canberra and the Australian Capital Territory were amalgamated into a single SD for the purpose of this study as no separate data was provided for the latter.

The SDs are defined by the ABS in terms of geographical polygons, giving the longitude and latitude of their vertices. This information is available in ESRI shapefile format, which facilitates the calculation of distances and the plotting of charts, as is set out below¹. In this study, all positions, distances and areas are expressed in terms of degrees of latitude and longitude, with 1° in spherical coordinates being approximately 60 nautical miles.

Though age was a relevant factor, mortality statistics were provided only to the age of 85. All statistics after that age were aggregated at age 85. The reason is that deaths after that age in individual SDs are few in number and would be identifiable, so it appears that privacy considerations prevail.

The ABS also provided population data for 1755 cities and towns across Australia in the mid census year (the smallest town having a population of only 24), together with their geographical coordinates. Again, this should not detract from the principles involved in this study.

Hospital data were provided by the Australian Institute of Health and Welfare [Australian Institute of Health and Welfare \(2017\)](#), an agency of the Australian government. Hospitals were categorized by the number of beds and geographical location. For the purpose of this study, only 347 of these hospitals, both private and public, have been included, as the number of 50 beds is considered to be the minimum for providing emergency care in critical conditions (such as accidents, cardiac arrest and stroke).

A depiction of the various town/city locations, and those of hospitals, is set out below in Figure 1.

¹ For example, with the use of standard Matlab functions.

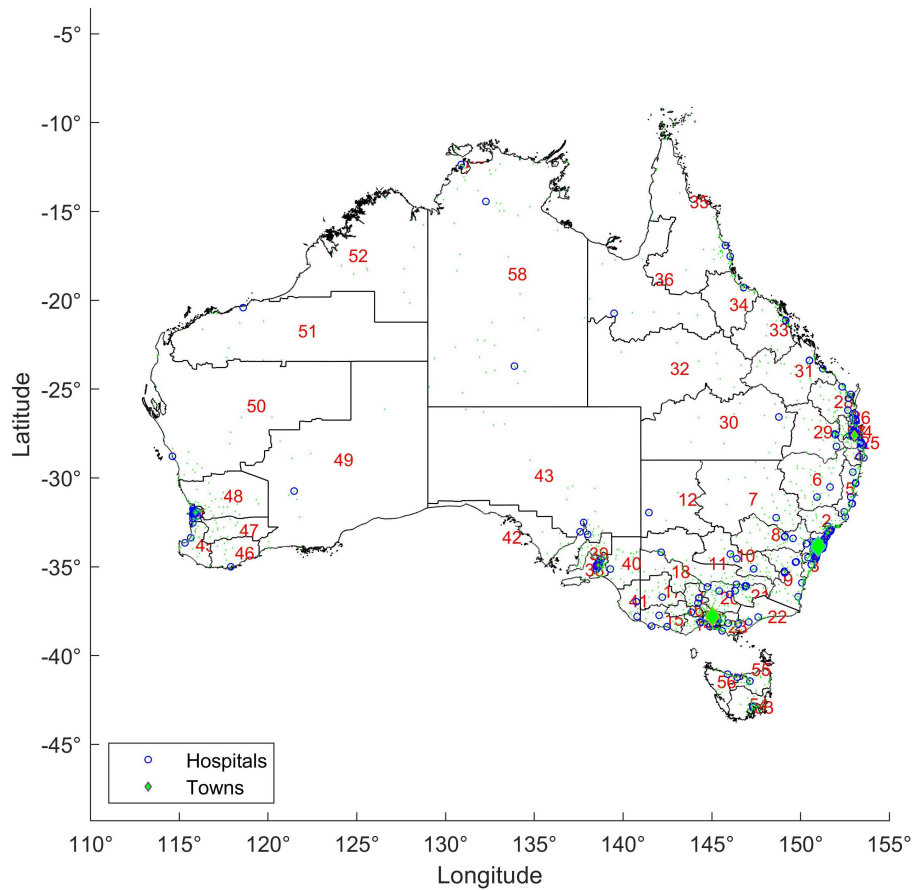


Figure 1. Towns and hospitals.

2.1. Notation

Denote:

- x age next birthday, for $x = 1, 2, \dots, n = 86$,
- r region, for $r = 1, 2, \dots, m = 59$,
- c_r city within region r ,
- h hospital,
- q_x age dependent mortality for age x ,
- $D_{r,x}$ number of deaths at age x in region r ,
- $X_{r,x}$ number of exposed lives at age x in region r ,
- $\rho(c_r)$ population of city c_r contained in region r ,
- $\gamma(c_r)$ the distance (in degrees) from c_r to the nearest hospital h .

Since not all the population in a given SD resides in a city or town, we assume that the rural population is distributed uniformly within the region and assess the average nearest distance to a hospital accordingly. The technicalities are set out in Appendix A.

Overall statistics in terms of geography, population, urbanization and hospitalization are set out in the following table. The towns in the ‘Other Territories’ are excluded from Table 1 below.

Table 1. Regional statistics.

SD	Statistical Division	Area	Male Population	Female Population	No. of Towns *	Ruralization	No. of Hospitals	Average Hospital Distance
1	Sydney	1.180	2,112,861	2,169,127	54	6%	61	0.165
2	Hunter	2.779	306,840	310,712	73	13%	10	0.603
3	Illawarra	0.819	205,886	208,818	46	11%	11	0.235
4	Richmond-Tweed	0.949	113,390	116,673	36	29%	5	0.322
5	Mid-North Coast	2.397	146,638	150,213	72	28%	7	0.324
6	Northern (NSW)	9.323	89,820	90,387	39	33%	3	1.054
7	North Western	18.868	58,670	57,641	27	32%	1	2.164
8	Central West	6.105	89,913	88,718	38	28%	3	0.800
9	South Eastern	5.138	104,421	102,955	46	40%	4	0.551
10	Murrumbidgee	6.297	77,592	76,454	36	26%	4	0.715
11	Murray	8.868	58,048	57,389	31	26%	3	0.896
12	Far West	13.887	11,421	11,500	5	12%	1	1.793
13	Melbourne	0.788	1,848,781	1,894,234	44	6%	71	0.131
14	Barwon	0.921	133,285	136,406	20	32%	4	0.419
15	Western District	2.344	50,956	51,549	25	34%	4	0.372
16	Central Highlands	1.219	72,583	74,984	21	23%	3	0.450
17	Wimmera	3.413	24,938	25,215	19	32%	1	0.639
18	Mallee	3.953	45,699	46,029	24	32%	2	0.942
19	Loddon	1.463	86,199	88,719	31	27%	4	0.393
20	Goulburn	2.752	101,682	100,753	52	34%	4	0.398
21	Ovens-Murray	1.773	47,753	48,358	29	29%	2	0.510
22	East Gippsland	3.238	41,661	41,255	24	37%	2	0.621
23	Gippsland	1.125	81,531	83,970	44	31%	3	0.303
24	Brisbane	0.543	900,397	919,365	24	5%	25	0.133
25	Gold Coast	0.122	256,603	261,575	3	22%	4	0.115
26	Sunshine Coast	0.283	144,723	150,361	19	26%	8	0.143
27	West Moreton	1.086	36,611	36,070	26	54%	0	0.382
28	Wide Bay-Burnett	4.360	134,483	135,056	48	49%	7	0.762
29	Darling Downs	7.057	112,598	114,543	33	28%	5	1.075
30	South West	29.092	13,580	12,786	12	37%	1	2.991
31	Fitzroy	10.440	102,989	97,396	33	26%	4	1.410
32	Central West	35.074	5922	5640	8	33%	0	3.701
33	Mackay	7.869	83,572	76,228	32	73%	2	1.528
34	Northern (QLD)	6.909	106,422	103,480	27	17%	2	1.407

Table 1. Cont.

SD	Statistical Division	Area	Male Population	Female Population	No. of Towns *	Ruralization	No. of Hospitals	Average Hospital Distance
35	Far North	23.008	125,711	121,584	60	26%	4	2.971
36	North West	26.434	17,680	15,533	10	18%	1	2.355
37	Adelaide	0.180	559,635	586,177	14	5%	22	0.073
38	Outer Adelaide	1.153	64,537	64,233	43	41%	0	0.649
39	Yorke and Lower North	1.988	23,031	22,463	28	40%	0	0.765
40	Murray Lands	4.742	35,435	34,048	22	44%	1	0.956
41	South East	2.157	32,733	31,759	15	32%	2	0.523
42	Eyre	6.963	17,994	16,834	12	36%	0	2.805
43	Northern (SA)	75.032	40,688	38,321	26	19%	3	3.766
44	Perth	0.514	758,396	760,352	24	9%	17	0.147
45	South West	2.783	111,608	108,400	32	18%	4	0.651
46	Lower Great Southern	3.804	28,455	27,314	12	32%	1	1.048
47	Upper Great Southern	4.430	9761	9017	13	45%	0	1.772
48	Midlands	10.451	27,918	25,446	33	46%	0	1.680
49	South Eastern	71.362	29,501	25,832	10	36%	1	3.923
50	Central	54.304	32,009	29,355	18	84%	2	3.789
51	Pilbara	44.214	24,665	19,424	14	14%	1	3.980
52	Kimberley	35.757	16,732	15,196	14	26%	0	5.628
53	Greater Hobart	0.150	99,799	105,682	19	14%	4	0.143
54	Southern	2.651	18,720	17,411	23	62%	0	0.641
55	Northern (Tas)	2.150	68,556	70,146	34	24%	3	0.591
56	Mersey-Lyell	2.434	54,481	55,156	25	28%	2	0.817
57	Darwin	0.259	60,551	53,811	6	11%	2	0.330
58	Northern Territory - Bal	115.970	48,764	47,501	51	44%	2	2.871
59	Canberra	0.080	165,151	168,688	2	3%	4	0.087
	Total	695.403	10,280,979	10,414,242	1661		347	

It is evident that some SDs are poorly serviced by hospitals—for example, the Northern Territory and Kimberley SDs. These may coincide with the areas of the highest indigenous population. We do not speculate on the reasons for this, whether it be the economics of low population density or the outcome of government health policy. However, a rural population is included with the assessment of the each SD, giving a notional rural population in $\rho(c_r)$ and its associated hospital proximity $\gamma(c_r)$.

2.2. A General Model

We hypothesize that deaths D can be explained by natural mortality q_x and the town/city populations within each region, along with the distances of those cities from hospitals. Thus, we investigate a model of the form

$$D_{r,x} = q_x X_{r,x} + \alpha_x B_r + \sigma_{r,x} \varepsilon_{r,x},$$

where

- α_x is the strength of age-based hospital proximity effects;
- $B_r = \sum_{c_r} \rho(c_r) \gamma(c_r)$, the population-weighted distance to the nearest hospital;
- $\sigma_{r,x}$ is a variance term (see below);
- $\varepsilon_{r,x}$ is a normal error term with constant variance.

In general, the suffixes r and x are omitted where the meaning is clear from context.

The variance σ^2 in the above model allows for heteroscedasticity. It is well known that both the Poisson and binomial models may be approximated by a normal distribution, where the population is high in relation to the mortality rate. This is a result of the Central Limit Theorem. Thus, a ‘continuous’ Poisson distribution may be adopted [Iliencko \(2013\)](#).²

Under the Poisson model for mortality, we could take $\sigma^2 = qX$, or under the binomial $\sigma^2 = q(1-q)X$. Alternatively, we could regard the proximity effect as part of the overall mortality, and take $\sigma^2 = qX + \alpha_x B_r$. In general, we avoid the binomial model in favor of the Poisson, which is simpler and leads to much of the same results. Under a negative binomial approach, $\sigma^2 = qX(1 + rqX)$ for some constant $r > 0$. All of these approaches, which are of increasing complexity, are examined below, in order to assess whether the errors ε may be found to be normal and have constant (hopefully unit) variance.

As with most statistical mortality models [Venter \(2001\)](#), the method of estimating the parameters in the model is taken as that of maximum likelihood (ML). In this instance, the likelihood is

$$\mathcal{L} = \prod_{r,x} \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(D - qX - \alpha B)^2}{2\sigma^2}}$$

and thus the log likelihood is, up to an additive constant³,

$$\mathcal{H} = -\frac{1}{2} \left[\sum_{r,x} \frac{[D - qX - \alpha B]^2}{\sigma^2} + \sum_{r,x} \ln(\sigma^2/X) \right].$$

² A continuity adjustment may be used for practical applications.

³ The constants are 2π and X .

An appropriate formula for model comparison is the Akaike Information Criterion *AIC* [Brockett \(1991\)](#)⁴ that allows for the number of parameters (whether in q, α , or σ^2) to be estimated, and favours models with the lowest level of

$$AIC = \#(q, \alpha, \sigma^2) - \mathcal{H}.$$

3. The Model with Heteroscedasticity

Though it is possible to examine models with homoscedastic errors, i.e., σ^2 is constant across ages and regions, we do not do so as the assumption is entirely unrealistic, as it would not take account of population size. Thus, some form of heteroscedasticity needs to be assumed. It is instructive to consider models with and without proximity effects, in order to gauge their overall significance. The truism is that neglecting heteroscedasticity produces unbiased but inefficient estimators. Thus, mortality estimates may suffer unwarranted volatility.

3.1. The Model without Proximity or Regionality

The raw ALT rates may be derived rigorously by considering a model of the form

$$D = q_x X + \sigma \varepsilon,$$

where $\sigma^2 = \lambda^2 X$, with λ being a constant across all ages and regions. The estimators for this model are the naive ratios that ignore regional data completely

$$\hat{q}_x^{alt} = \frac{\sum_r D}{\sum_r X}.$$

However, the estimates of the variance parameter λ are less intuitive

$$\hat{\lambda}^2 = \frac{1}{mn} \sum_{r,x} (D - \hat{q}_x^{alt} X)^2 = 0.0805$$

and with

$$AIC = n + 1 + \frac{mn}{2} [1 + \ln(\hat{\lambda}^2)].$$

This type of model has several shortcomings. First, the variance term λX , whilst allowing the greatest errors for the greatest populations, does not allow for ages where mortality is lowest (say near birth) or highest. Second, it does not discriminate between regions of different age structure and/or mortality. The *AIC* statistics are poor, which is not surprising as the model does not give any credence to regional data.

3.2. The Model with Regionality but Not Proximity

It is clear that the general model above encapsulates the case where proximity effects are absent, i.e., $B_r = 0$. This may provide a first approximation to the parameter q in the general model. It is of interest in its own right, as it allows comparison with the graduated rates set out in ALT.

⁴ Strictly speaking, this is half the usual definition of *AIC*. It also excludes the term resulting from $\sum \ln(X)$, which is constant across all models.

In this case, we take $\sigma^2 = qX$, and the estimators for q from maximizing the log likelihood can be derived analytically:

$$\hat{q} = \frac{\sqrt{m^2 + 4 \sum_r X_r \cdot \sum_r D_r^2 / X_r} - m}{2 \sum_r X_r}, \tag{1}$$

where $m = 59$ is the number of SDs. This is a result of the more general model in Section 4, where $\rho_r = 0$ and $B_r = 0$.

A comparison of these estimated mortality rates, which allow for heteroscedasticity, and both the raw and graduated rates set out in ALT2005-07 are in Figure 2 as follows.

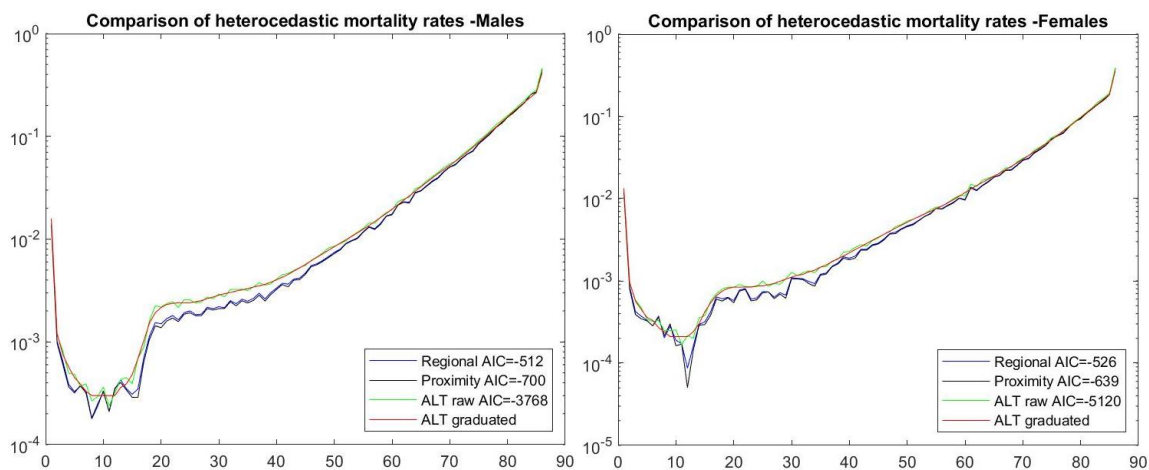


Figure 2. Regional mortality rates.

It is apparent that, by allowing for heteroscedasticity, which favors the regions with the lowest mortality rates, and thus volatility of deaths, the estimated rates are generally lower than those derived in ALT without such considerations, and with lower inter-age volatility. The graduated rates Australian Government Actuary (2009) were reached using cubic splines and human judgement, so it is not possible to ascribe an AIC . However they would not differ significantly from that for the raw rates.

3.2.1. A Regionalized Model

Another model assumes that age and regional effects can be separated:

$$D = (q_x + \gamma_r) X + \sigma \epsilon$$

again with $\sigma^2 = (q_x + \gamma_r) X$ and with overall mortality $\tilde{q}_{r,x} = q_x + \gamma_r$. This is referred to as a 'Regionalized Model'. It has a high AIC and is the nearest competitor to models with proximity, as it allows for regional effects to manifest directly. This may be depicted in Figure 3 below.

Under this regionalized model, it is possible to identify the SDs with the highest overall mortality, being those with the highest γ_r . This is depicted graphically in Figure 4 as follows.

It comes as no surprise that the SDs with the highest mortality are also those with the highest level of indigency and sparsest population. It also appears that females do not receive the same level of medical care as males in male dominated regions, where mining or farming predominate. However, it would be highly ethically challenging to price insurance on such as a basis, as this would be arbitrary and discontinuous (for example, how would borderline populations be treated?). To this end, we examine the relevance of an objective variable, which is continuous and largely determined by the population itself, namely proximity to hospitals and medical care. This is the antithesis to regionality.

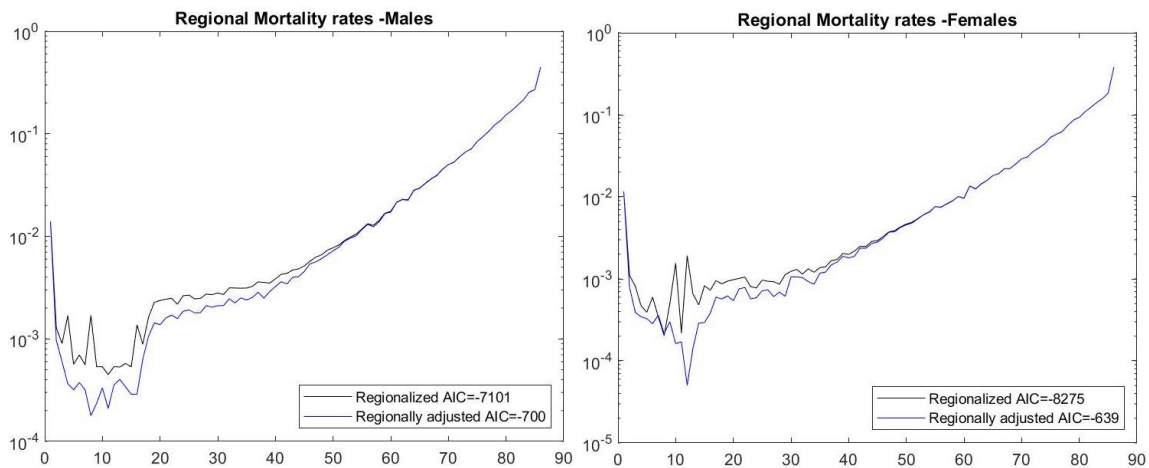


Figure 3. Regionalized mortality rates = by age.

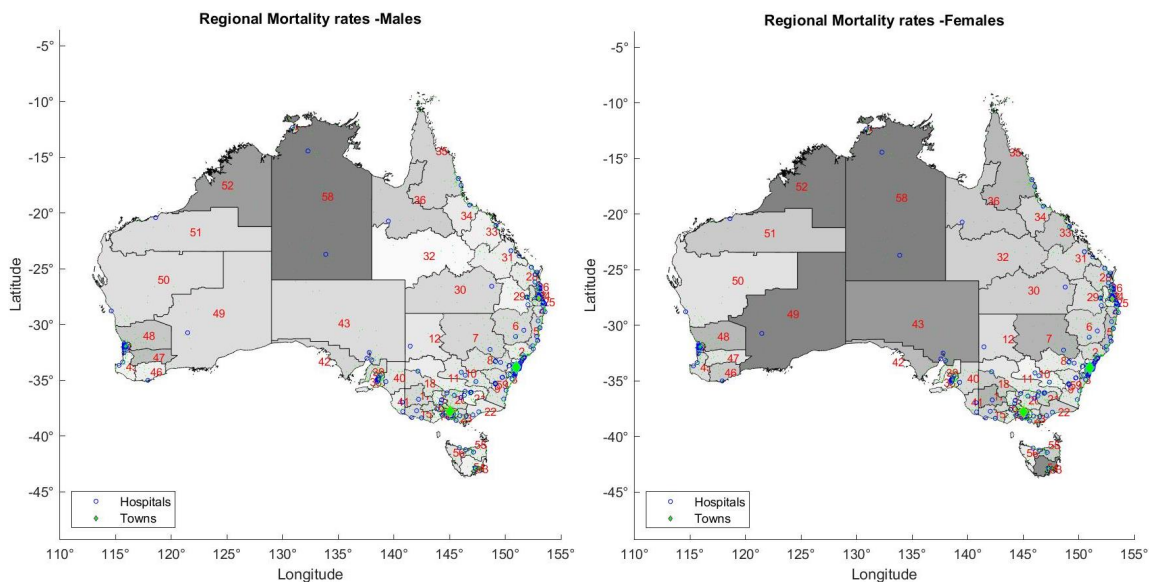


Figure 4. Regionalized mortality rates—by region.

4. The Model with Proximity

Where proximity effects are allowed for, it is not always possible to derive analytic expressions. Thus, numerical optimization is needed. However the result is that mortality rates specific to both age and proximity may be estimated. To test the robustness of the model from a statistical viewpoint, we employ the *AIC* to assess whether proximity effects are justified.

The simplest form of a proximity model may be written

$$D = q_x X + \alpha_x B + \sigma \epsilon,$$

where $\sigma^2 = q_x X$. Note that, in this version, the regional factors γ_r in Section 3.2 (which are applied to X) are replaced by age-based proximity factors α_x (which are applied to the regional distance data in B). Fortunately, the ML estimates of the parameters q_x and α_x in this simplest version of the model extend the regional model in Section 2, and may be found in closed form. The details are set out in Appendix B.

The significance of the proximity factors may be assessed from the 5% and 95% bounds for the factors α_x in Figure 5:

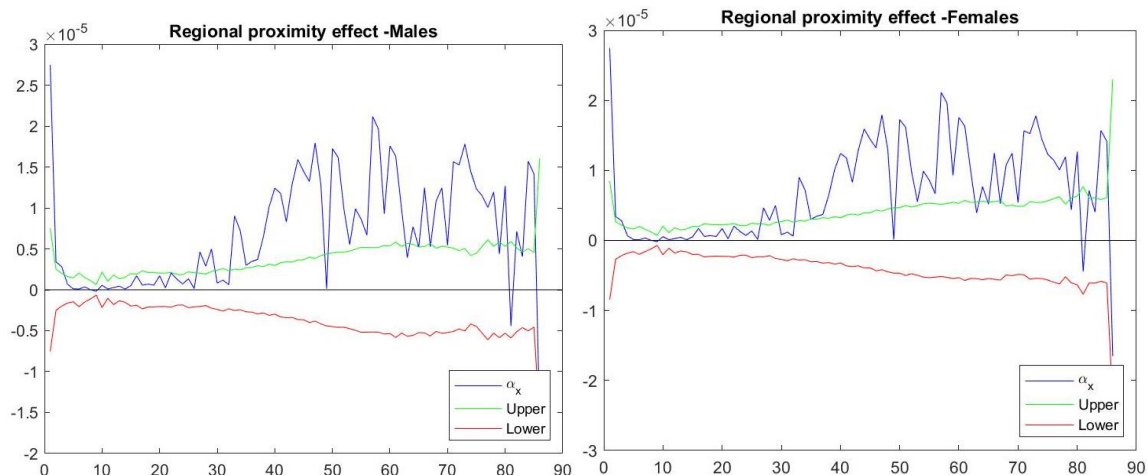


Figure 5. Bounds for regional mortality factors.

The charts suggest the significance of the proximity factors α_x at the 95% level. However, this type of proximity model has to be diagnosed for the structure of its residual errors, and how they compare with regionally based models. This is the subject of the next section.

5. Diagnostics

It remains to assess whether the residuals arising from estimation of the various models satisfy the usual assumptions of normality.

There are two possible explanations for any absence of normality. The first is that the residuals do not in fact obey a Poisson distribution, which assumes independence of deaths. This is highly likely in an industrial context. The second explanation is simply that the recording of deaths is subject to error, either in terms of age or location of death. Thus, the diagnostics of the residual errors are undertaken with and without exclusion of ages/regions where the number of deaths is recorded as being 6 or below (i.e., less than two deaths per annum). Some 47% of regional/age groups fall into this category,

Since the negative binomial distribution (NB) allows for over dispersion of residuals, we examine whether it provides a better fit to the data. In biostatistics, the Negative Binomial allows for contagion in deaths [Kemp and Kemp \(2005\)](#) and has been successfully employed for mortality data. The Poisson model gives both the mean and variance of deaths as $q_x X$. In contrast, by assuming nonindependence of deaths, the NB gives a variance of $\sigma^2 = q_x X (1 + c q_x X)$ for some contagion parameter c . Thus, the variance cannot be directly proportional to exposures. We may extend this to the case where the underlying mortality is affected by proximity. i.e., with

$$\sigma^2 = (q_x X + \alpha_x B) [1 + c (q_x X + \alpha_x B)].$$

The mortality estimates under both the Poisson and Negative Binomial (NB) models are as follows in Figure 6:

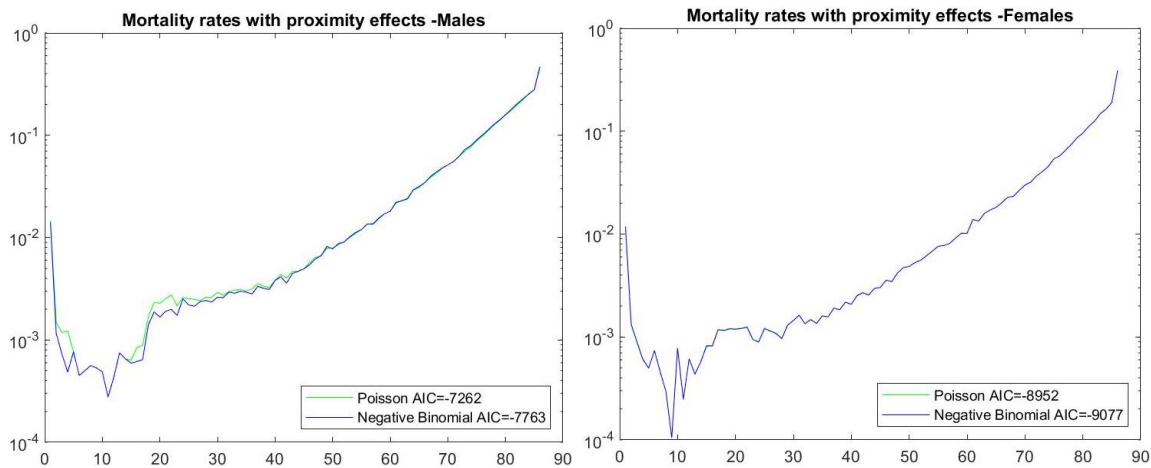


Figure 6. Comparative mortality rates.

To assess the residuals, normal probability plots are given for the errors as shown below. The following chart examines the residuals resulting from the Poisson model in Figure 7.

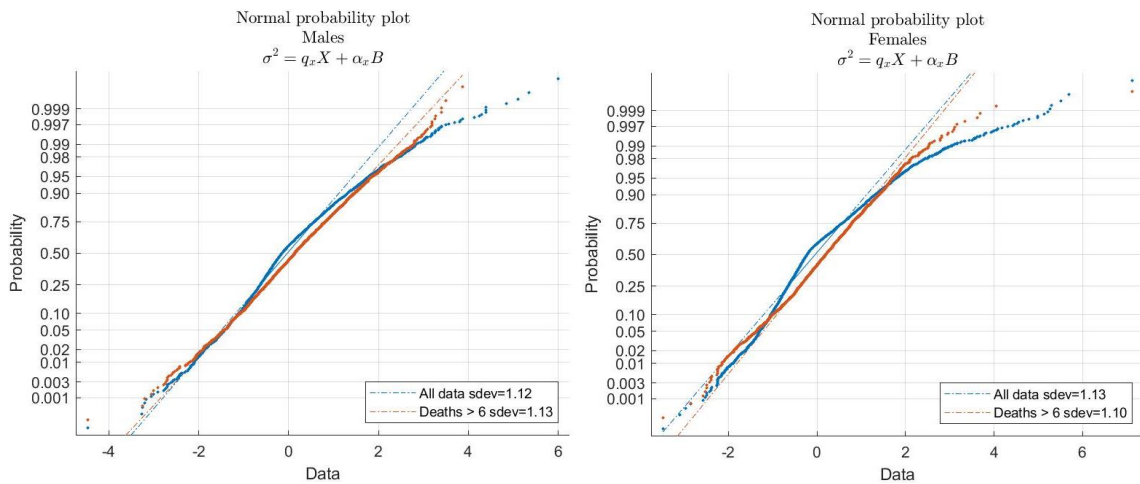


Figure 7. Normal probability plot—Poisson.

The following chart examines the residuals resulting from the Negative Binomial model in Figure 8.

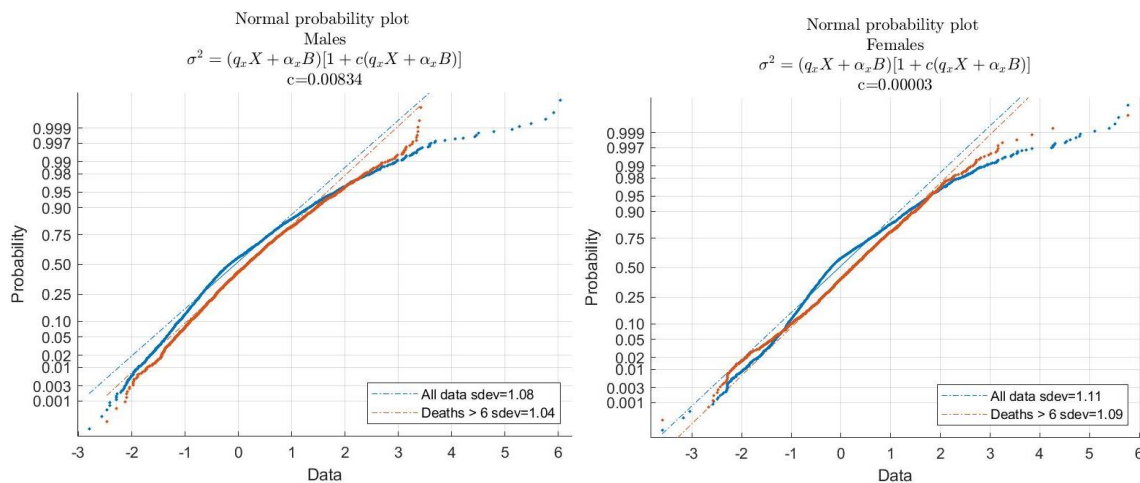


Figure 8. Normal probability plot—negative binomial.

It may be observed that the residual errors, with the variances shown, do (almost) satisfy the assumption of constant (unit) variance. However, the plots are left (i.e., negatively) skewed.

The conclusion is that the effect of allowing for non-Poisson residuals has only a slight effect on the estimation of the mortality rates and proximity effects. However, they do resolve the issues of skewness and normality with the Poisson model, as the standard deviations of the NB residuals are close to unity, the presumption in estimation.

Moreover, the contagion parameters c in the NB model have a real significance: that for males ($c = 0.008$) is well above that for females ($c = 0.00003$). The obvious explanation is that males are engaged *en masse* to a greater extent than females in hazardous industries, such as in mining, energy and construction.

The strength of the proximity effect is tabulated in Appendix C, being the ratio of the proximity effect to total mortality rate $\frac{\alpha_x B}{q_x X + \alpha_x B}$. The overall effect is small, being dominated by the capital cities, but very significant for some regions. It is not surprising that sparsely populated regions suffer most from the tyranny of distance, notably in the Kimberley and Pilbara, which are mining regions. The major cities are much better served for medical treatment and enjoy the least tyranny of distance. However, there are a few, perhaps counterintuitive, observations.

Expressed as a percentage of total mortality, the proximity effect per 10 km is set out in Appendix D (using 1 nautical mile = 1.852 km). These results indicate overall that 10 km distance is consistent with no more than a 1% increase in mortality rate, a result consistent with the UK Nicholl et al. (2007) but applied to much larger distances in Australia and to all conditions, even those not involving ambulances.

Proximity effects appear strongest near birth, or during the teenage years. This would attest to the efficacy of medical treatment for these age groups, which suffer from accidental causes that are most effectively treated when administered in a timely manner. Infant mortality is also significant and with distances of 10 km are consistent with a 27% increase in mortality Karra et al. (2017).

A surprising result is that proximity for the elderly is a negative factor, even strongly negative in sparse regions, for year 85 onwards. This does not suggest that the elderly suffer from being close to medical treatment. Rather, it suggests that those with terminal illnesses gravitate to where such treatment is more readily available, and vice versa.

A summary of the various models above is as follows in Table 2:

Table 2. Comparison of AICs.

Model	Males	Females
No regionality	−3768	−5120
Regionalized	−7101	−8271
Proximity	−7262	−8952
Proximity NB	−7796	−9077

6. Indigenuity

It is controversial why the indigenous people—the aborigines—suggest higher mortality rates than others. The impact on national mortality is limited—they comprise just 3.3% of the population⁵.

The greatest population is in the Northern Territory (SD 58) and Western Australia (SDs 49–52). While 80% and 40%, respectively, live in remote regions of these SDs, 80% of the total population lives in urbanized areas overall. There are two competing theories for the higher indigenous mortality in regions where they predominate:

- their lifestyle and culture leads to riskier outcomes (a racist argument); or

⁵ <https://www.creativespirits.info/aboriginalculture/people/aboriginal-population-in-australia>

- their remoteness from health care.

The proximity effects of Appendix D (proximity effect per 10 km) suggest the latter, as it is a form of deprivation. However, much greater data are needed to confirm this conclusion.

7. Conclusions

From a comparison of homoscedastic and heteroscedastic models for mortality, it becomes glaringly obvious that the variance of mortality rates is essential to their estimation. It is also evident that age is not the only explanatory factor in modelling mortality. Region, but more tellingly hospital proximity, is a vital factor. Proximity is a continuous and objective rating factor, largely chosen by the individual that can be employed on a logical and defensible basis. For this to be undertaken appropriately, the structure of residual errors must be chosen carefully. The results of this paper, and common logic, suggest the Negative Binomial for modelling contagion in populations.

The other observation that can be made is that there are numerous difficulties (indeed futility), with forecasting mortality. It is a truism that medical advances drive the trends in mortality, as do warfare and technology. This paper illustrates that the accessibility to medical treatment is equally important.

Unfortunately, this has political and financial dimensions. It is intuitive that distance affects mortality in a causal fashion, as the time taken to be hospitalized impacts directly the promptness of treatment, which is critical for many conditions, especially for the young, and, for example, cardiac conditions and stroke. This aspect is presumed in all the literature Nicholl. The issue then becomes the costs of establishing a hospital, with the appropriate medical facilities, in a given location versus the benefits to the local community. This is beyond the scope of this paper.

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Appendix A. Assessing the Impact of Rural Areas

The bulk of the population in each SD is in the cities and towns, for which precise geographical coordinates are known, and the distance from the nearest hospital calculated. However, a significant proportion lies in rural areas, especially for the less developed SDs. For want of better information, we assume that rural populations are distributed uniformly within each SD.

To calculate the average nearest distance for these rural populations is no trivial matter, as the SDs themselves, which are defined by polygons, are in some cases non-convex, or even not simply connected (as there are a large number of islands on Australia's coastline). Though straightforward in principle, the following procedure may be adopted:

1. The 'catchment area' of each hospital is calculated. This is a polygon whose interior consists of points, all of which have the given hospital as its nearest. The polygon may be constructed by drawing a line segment between a given hospital, and all other hospitals, and then taking a perpendicular through the midpoint of each line segment, The perpendiculars establish the catchment area of each hospital. By definition, the catchment areas cannot intersect. The process is illustrated in Figure A1 below for SD = 58, which includes numerous outlying islands.
2. Each SD is divided into catchment areas for the various hospitals. It should be noted that a hospital need not actually be in a SD, as some remote regions have their nearest hospital in another SD.
3. The intersection of SDs and catchment areas is polygons which themselves may not be simply connected. Thus, for the purpose of assessing average nearest distance, a triangulation of each polygon must be made. Integration over the triangles comprising each polygon may then be undertaken to calculate average nearest distance. The results for each SD are set out in Table 1.

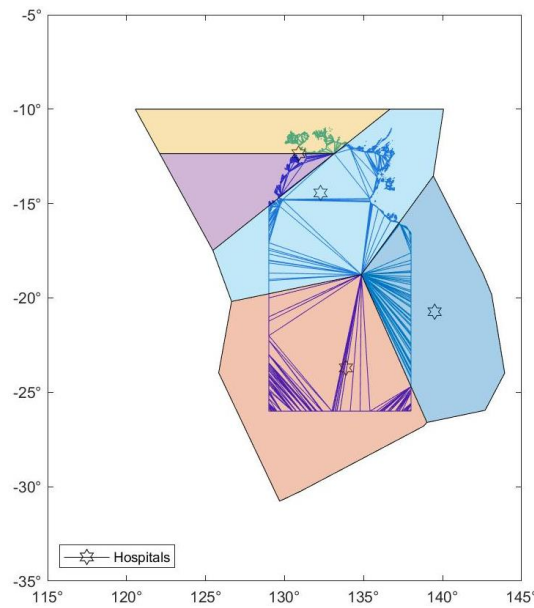


Figure A1. Northern Territory Triangulation by hospital catchment area.

Appendix B. The Model with Proximity

We examine the heteroscedastic model

$$D = q_x X + \alpha_x B + q_x X \varepsilon$$

with log likelihood

$$\mathcal{H} = -\frac{1}{2} \left[\sum_{r,x} \frac{[D - q_x X - \alpha_x B]^2}{q_x X} + \sum_{r,x} \ln(q_x) \right].$$

Dropping subscripts, the first derivatives of \mathcal{H} are

$$\frac{\partial \mathcal{H}}{\partial \alpha} = \frac{1}{q} \sum_r (D - qX - \alpha B) \frac{B}{X}$$

and

$$\begin{aligned} \frac{\partial \mathcal{H}}{\partial q} &= \frac{1}{q} \sum_r (D - qX - \alpha B) + \frac{1}{2q^2} \sum_r \frac{[D - qX - \alpha B]^2}{X} + \frac{m}{2q} \\ &= \frac{1}{q^2} \left[\begin{array}{l} q \sum_r D - q^2 \sum_r X - \alpha q \sum_r B \\ + \frac{1}{2} \sum_r \frac{D^2}{X} + \frac{1}{2} q^2 \sum_r X + \frac{1}{2} \alpha^2 \sum_r \frac{B^2}{X} \\ - q \sum_r D - \alpha \sum_r \frac{BD}{X} + \alpha q \sum_r B - \frac{1}{2} m q \end{array} \right]. \end{aligned}$$

For simplicity of notation, denote $\beta = \sum_r B$; $\delta = \sum_r D$; $\zeta = \sum_r X$; $\varphi = \sum_r \frac{B^2}{X}$; $\psi = \sum_r \frac{D^2}{X}$; $\chi = \sum_r \frac{DB}{X}$. Then, the above derivatives may be written as

$$\frac{\partial \mathcal{H}}{\partial \alpha} = \frac{1}{q} [\chi - \beta q - \alpha \varphi]$$

and

$$\frac{\partial \mathcal{H}}{\partial q} = \frac{1}{2q^2} [\psi - q^2 \zeta + \varphi \alpha^2 - 2\chi \alpha - m q]. \tag{A1}$$

From these first derivatives, we may calculate the second derivatives. It is clear that the off diagonal terms in $\frac{\partial^2 \mathcal{H}}{\partial^2 \alpha}$, $\frac{\partial^2 \mathcal{H}}{\partial^2 q}$ and $\frac{\partial^2 \mathcal{H}}{\partial \alpha \partial q}$ are zero. Hence, the only non-zero terms are:

$$\frac{\partial^2 \mathcal{H}}{\partial \alpha \partial q} = -\frac{1}{q^2} [\chi - \alpha \varphi], \tag{A2}$$

$$\frac{\partial^2 \mathcal{H}}{\partial^2 \alpha} = -\frac{\varphi}{q},$$

$$\frac{\partial^2 \mathcal{H}}{\partial^2 q} = -\frac{1}{q^3} [\psi + \varphi \alpha^2 - 2\chi \alpha] + \frac{m}{2q^2}. \tag{A3}$$

Equating the first derivatives to zero for a minimum in \mathcal{H} we get $\alpha = \frac{\chi - \beta q}{\varphi}$ and substituting in Label (A1)

$$-\xi q^2 + \psi + \varphi \left(\frac{\chi}{\varphi} - \frac{\beta}{\varphi} q \right)^2 - 2\chi \left(\frac{\chi}{\varphi} - \frac{\beta}{\varphi} q \right) - m q = 0,$$

which simplifies to

$$q^2 \left(\xi - \frac{\beta^2}{\varphi} \right) + m q - \left(\psi - \frac{\chi^2}{\varphi} \right) = 0$$

and hence an exact ML estimator for q is:

$$\hat{q} = \frac{\sqrt{m^2 + 4 \left(\xi - \frac{\beta^2}{\varphi} \right) \left(\psi - \frac{\chi^2}{\varphi} \right)} - m}{2 \left(\xi - \frac{\beta^2}{\varphi} \right)}. \tag{A4}$$

We take the positive root above since $\beta^2 \leq \xi \varphi$ and $\chi^2 \leq \psi \varphi$ from Cauchy's inequality. In the case that $B = 0$, we have $\beta = \chi = \varphi = 0$, and the expression for \hat{q} reduces to that in Equation (1).

The Hessian matrix, $\nabla^2 \mathcal{H}$, which is used to assess the variance of the estimators, is then given by evaluating the second derivatives at the value for \hat{q} :

$$\frac{\partial^2 \mathcal{H}}{\partial \alpha \partial q} = -\frac{\beta}{\hat{q}},$$

$$\frac{\partial^2 \mathcal{H}}{\partial^2 q} = -\frac{1}{\hat{q}^3} \left[\psi + \frac{\beta^2 \hat{q}^2 - \chi^2}{\varphi} \right] + \frac{m}{2\hat{q}^2}$$

$$-\nabla^2 \mathcal{H} = \begin{bmatrix} \frac{\varphi}{\hat{q}} & & & \\ & \frac{\beta}{\hat{q}} & & \\ & & \frac{1}{\hat{q}^3} \left[\psi + \frac{\beta^2 \hat{q}^2 - \chi^2}{\varphi} - \frac{m}{2\hat{q}} \right] & \\ & & & \end{bmatrix}.$$

For convenience of notation, note that $\frac{\varphi}{\hat{q}}$ refers to the diagonal matrix with $\frac{\varphi}{\hat{q}}$ as its diagonal, etc. Since $\nabla^2 \mathcal{H}$ can be partitioned into four diagonal matrices, its inverse can be determined exactly:

$$-\left(\nabla^2 \mathcal{H}\right)^{-1} = \begin{bmatrix} \frac{\varphi}{\hat{q}\Delta} & -\frac{\beta}{\hat{q}\Delta} \\ -\frac{\beta}{\hat{q}\Delta} & \hat{q} \end{bmatrix},$$

where $\Delta = \frac{\varphi}{\hat{q}} \frac{1}{\hat{q}^3} \left[\psi + \frac{\beta^2 \hat{q}^2 - \chi^2}{\varphi} - \frac{m}{2\hat{q}} \right] - \frac{\beta^2}{\hat{q}^2} = \frac{\varphi}{\hat{q}^4} \left[\psi - \frac{\chi^2}{\varphi} - \frac{m}{2\hat{q}} \right]$. The Fisher information matrix $-\left(\nabla^2 \mathcal{H}\right)^{-1}$ may then be used to assess error bounds for the parameter estimates in Section 4.

Appendix C

Table A1. Proximity Effects—Males.

SD	Statistical Division	1–5	6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75	76–80	81–85	≥ 86	Total
1	Sydney	1.9%	1.1%	0.8%	5.4%	3.6%	2.2%	1.9%	2.6%	2.4%	1.5%	0.7%	0.8%	0.6%	0.5%	0.3%	0.2%	0.1%	0.0%	0.5%
2	Hunter	13.4%	7.7%	5.5%	28.9%	23.9%	18.2%	15.1%	18.5%	16.2%	9.7%	4.8%	4.8%	3.5%	3.1%	1.9%	1.1%	0.6%	−0.1%	2.7%
3	Illawarra	6.1%	3.1%	2.2%	13.9%	11.4%	8.5%	6.8%	8.6%	7.0%	4.1%	2.0%	2.0%	1.4%	1.1%	0.7%	0.4%	0.2%	−0.1%	1.1%
4	Richmond-Tweed	6.2%	3.1%	2.1%	13.4%	13.3%	10.0%	7.6%	8.7%	6.9%	3.6%	1.7%	1.7%	1.4%	1.1%	0.6%	0.3%	0.2%	0.0%	0.9%
5	Mid-North-Coast	17.9%	9.3%	6.2%	34.7%	37.2%	29.4%	22.9%	25.3%	20.2%	11.5%	5.4%	5.3%	3.7%	3.0%	1.8%	1.0%	0.6%	−0.1%	2.8%
6	Northern (NSW)	19.2%	11.4%	8.3%	40.2%	37.9%	30.3%	25.1%	28.9%	25.2%	15.5%	7.7%	7.5%	5.5%	4.7%	3.0%	2.0%	1.2%	−0.3%	4.8%
7	North-Western	31.1%	19.9%	15.1%	60.1%	58.0%	46.9%	40.2%	44.7%	40.0%	27.0%	15.1%	14.7%	10.9%	9.3%	6.3%	3.8%	2.7%	−0.7%	9.9%
8	Central-West	14.6%	8.3%	6.1%	31.3%	29.1%	22.1%	18.0%	21.8%	18.9%	11.3%	5.5%	5.4%	4.1%	3.5%	2.2%	1.4%	0.8%	−0.2%	3.4%
9	South-Eastern	17.2%	9.8%	6.8%	36.3%	35.3%	26.4%	20.6%	23.0%	19.4%	11.5%	5.7%	5.5%	4.1%	3.5%	2.3%	1.4%	0.8%	−0.2%	3.6%
10	Murrumbidgee	14.8%	8.1%	6.0%	30.3%	27.4%	21.2%	18.0%	21.8%	18.8%	11.5%	5.9%	6.1%	4.8%	3.8%	2.4%	1.4%	0.8%	−0.2%	3.7%
11	Murray	23.1%	13.8%	9.5%	44.7%	42.8%	32.0%	27.5%	32.0%	27.8%	16.9%	8.4%	8.5%	6.5%	5.3%	3.4%	1.9%	1.1%	−0.3%	5.1%
12	Far-West	50.6%	37.0%	28.8%	74.7%	73.0%	64.9%	57.8%	62.9%	56.9%	40.6%	23.7%	22.7%	19.6%	16.8%	10.1%	5.4%	4.0%	−1.2%	15.5%
13	Melbourne	1.3%	0.8%	0.6%	3.5%	2.3%	1.5%	1.3%	1.7%	1.6%	1.0%	0.5%	0.5%	0.4%	0.3%	0.2%	0.1%	0.1%	0.0%	0.3%
14	Barwon	6.3%	3.4%	2.3%	14.6%	12.4%	8.8%	6.9%	8.6%	7.5%	4.4%	2.1%	2.1%	1.6%	1.4%	0.8%	0.5%	0.2%	−0.1%	1.2%
15	Western-District	27.0%	14.1%	9.7%	46.0%	44.7%	35.7%	29.2%	33.2%	28.4%	18.3%	9.1%	9.3%	7.4%	6.3%	3.8%	2.2%	1.2%	−0.3%	5.5%
16	Centra-	6.1%	3.2%	2.2%	13.2%	11.4%	8.9%	7.1%	8.6%	7.2%	4.3%	1.9%	2.0%	1.5%	1.3%	0.8%	0.5%	0.3%	−0.1%	1.2%
17	Wimmera	30.6%	16.9%	11.8%	51.7%	51.4%	41.5%	34.8%	37.4%	31.5%	19.3%	10.3%	9.9%	7.8%	6.1%	3.5%	2.0%	1.2%	−0.3%	5.3%
18	Mallee	35.2%	21.5%	16.0%	60.6%	59.0%	47.0%	41.9%	45.4%	41.5%	27.9%	15.6%	15.8%	12.3%	10.0%	6.6%	3.5%	2.0%	−0.5%	9.1%
19	Loddon	7.1%	3.5%	2.4%	15.5%	14.3%	11.0%	8.5%	9.8%	8.2%	4.4%	2.1%	2.1%	1.6%	1.4%	0.9%	0.5%	0.3%	−0.1%	1.3%
20	Goulburn	9.5%	5.1%	3.5%	22.3%	22.1%	16.3%	12.2%	13.7%	11.9%	6.9%	3.3%	3.3%	2.4%	2.1%	1.3%	0.8%	0.4%	−0.1%	2.0%
21	Ovens-Murray	21.2%	12.3%	8.3%	39.1%	38.7%	30.4%	24.6%	28.2%	24.0%	15.0%	7.4%	7.6%	6.0%	5.1%	3.5%	1.9%	1.1%	−0.3%	4.9%
22	East-Gippsland	20.6%	11.5%	7.8%	39.9%	38.7%	29.3%	25.2%	27.8%	23.9%	13.7%	6.3%	6.0%	4.4%	3.5%	2.3%	1.3%	0.8%	−0.2%	3.6%
23	Gippsland	8.5%	4.1%	2.8%	17.4%	16.9%	12.7%	9.9%	11.2%	9.3%	5.3%	2.5%	2.4%	1.8%	1.5%	0.9%	0.5%	0.3%	−0.1%	1.4%
24	Brisbane	3.2%	1.9%	1.4%	8.3%	5.8%	4.0%	3.3%	4.5%	4.2%	2.6%	1.2%	1.2%	1.0%	1.0%	0.7%	0.4%	0.2%	0.0%	0.9%
25	Gold-Coast	1.7%	1.0%	0.7%	4.4%	3.1%	2.0%	1.7%	2.3%	2.1%	1.2%	0.6%	0.6%	0.4%	0.4%	0.2%	0.1%	0.1%	0.0%	0.3%
26	Sunshine-Coast	3.3%	1.7%	1.2%	8.3%	7.5%	5.2%	3.8%	4.7%	3.9%	2.1%	1.0%	1.0%	0.7%	0.6%	0.4%	0.2%	0.1%	0.0%	0.5%
27	West-Moreton	9.3%	4.9%	3.3%	22.7%	22.8%	16.9%	12.3%	13.5%	10.9%	6.6%	3.1%	2.9%	2.1%	1.8%	1.3%	0.9%	0.5%	−0.1%	2.1%
28	Wide-Bay-Burnett	16.3%	8.6%	5.8%	35.4%	34.1%	25.8%	20.4%	22.9%	19.5%	11.3%	5.4%	4.8%	3.2%	2.6%	1.8%	1.1%	0.7%	−0.2%	2.9%
29	Darling	12.5%	7.3%	5.1%	29.3%	24.8%	19.4%	16.0%	19.4%	17.4%	10.4%	5.1%	5.2%	3.8%	3.3%	2.1%	1.3%	0.7%	−0.2%	3.1%
30	South-West	43.7%	31.1%	28.2%	76.0%	70.9%	59.1%	52.7%	59.4%	55.7%	41.4%	27.0%	26.5%	22.3%	20.2%	13.3%	9.0%	7.4%	−1.4%	20.2%

Table A1. Cont.

SD	Statistical Division	1–5	6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75	76–80	81–85	≥ 86	Total
31	Fitzroy	17.5%	10.6%	7.6%	39.0%	32.7%	24.6%	21.1%	25.3%	22.2%	14.0%	7.5%	8.1%	6.6%	6.0%	4.0%	2.5%	1.6%	−0.4%	5.9%
32	Central-West	53.8%	42.4%	39.3%	81.1%	75.7%	67.7%	62.4%	67.5%	64.4%	51.1%	30.5%	34.2%	25.3%	22.2%	14.6%	9.7%	6.7%	−1.7%	22.3%
33	Mackay	35.1%	22.7%	17.3%	62.7%	53.4%	41.2%	36.5%	42.0%	39.0%	26.8%	15.1%	16.4%	13.8%	13.5%	10.1%	6.3%	4.0%	−1.1%	13.6%
34	Northern (QLD)	40.5%	26.9%	20.2%	64.5%	55.5%	46.7%	42.5%	49.8%	47.7%	34.3%	20.3%	20.8%	17.9%	16.2%	11.9%	7.5%	4.4%	−1.1%	15.8%
35	Far-	24.7%	15.8%	11.7%	53.1%	46.8%	34.4%	28.1%	33.2%	30.4%	20.3%	10.8%	11.1%	9.2%	8.7%	6.1%	4.2%	2.5%	−0.6%	8.9%
36	North-West	56.3%	43.2%	39.3%	82.9%	75.0%	64.9%	61.3%	69.3%	68.2%	57.1%	40.6%	41.7%	35.7%	39.7%	29.9%	24.9%	19.5%	−6.4%	40.2%
37	Adelaide	0.6%	0.4%	0.2%	1.5%	1.1%	0.7%	0.6%	0.8%	0.7%	0.4%	0.2%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.1%
38	Outer-Adelaide	14.0%	7.3%	5.1%	28.5%	29.2%	22.0%	16.4%	17.6%	14.9%	8.5%	4.3%	4.2%	3.2%	2.7%	1.8%	1.1%	0.6%	−0.1%	2.6%
39	Yorke	24.4%	13.0%	9.4%	46.0%	45.2%	35.8%	30.3%	31.1%	25.0%	15.6%	7.1%	6.7%	4.4%	3.6%	2.3%	1.3%	0.8%	−0.2%	3.6%
40	Murray-Lands	25.3%	14.7%	10.4%	47.7%	45.6%	34.6%	28.3%	30.4%	27.9%	17.4%	8.8%	8.7%	6.4%	5.6%	3.5%	2.1%	1.2%	−0.3%	5.4%
41	South-East	36.7%	22.6%	16.4%	61.2%	56.0%	44.6%	39.6%	42.3%	39.1%	26.6%	14.7%	15.4%	12.9%	11.4%	7.6%	4.1%	2.5%	−0.6%	10.3%
42	Eyre	46.8%	29.2%	22.4%	70.5%	66.1%	55.6%	49.3%	52.8%	50.1%	34.9%	19.7%	20.6%	16.0%	14.7%	10.3%	5.7%	3.3%	−0.8%	13.6%
43	Northern SA	44.6%	28.7%	22.8%	69.4%	66.6%	54.8%	48.4%	52.9%	47.8%	34.9%	20.8%	21.0%	16.4%	13.8%	9.9%	6.3%	4.2%	−1.0%	14.6%
44	Perth	1.5%	0.9%	0.6%	3.6%	2.6%	1.8%	1.6%	2.0%	1.8%	1.1%	0.5%	0.5%	0.4%	0.4%	0.3%	0.2%	0.1%	0.0%	0.4%
45	South-West	23.4%	13.1%	9.0%	44.6%	43.5%	32.7%	27.0%	29.7%	26.0%	16.4%	8.5%	8.4%	6.3%	5.1%	3.3%	2.0%	1.2%	−0.3%	5.2%
46	Lower	42.2%	26.7%	20.6%	66.6%	66.6%	54.3%	48.9%	52.5%	45.8%	32.7%	17.9%	18.1%	15.1%	12.4%	8.3%	5.2%	3.0%	−0.8%	12.4%
47	Upper-Great-Southern	29.9%	18.7%	15.6%	63.3%	57.2%	43.0%	34.6%	38.5%	36.4%	23.0%	12.0%	12.2%	9.6%	9.0%	6.6%	4.0%	2.9%	−0.5%	9.0%
48	Midlands	29.2%	16.6%	12.6%	57.5%	54.6%	43.3%	34.2%	36.7%	30.8%	20.4%	10.7%	10.0%	7.7%	6.5%	4.6%	3.1%	2.1%	−0.6%	7.7%
49	South-Eastern	53.4%	38.5%	33.2%	80.2%	72.3%	60.4%	55.2%	61.2%	59.8%	48.3%	32.6%	34.5%	31.9%	32.2%	27.6%	22.1%	17.3%	−4.3%	34.5%
50	Central	52.4%	36.0%	29.9%	77.6%	75.3%	64.3%	56.8%	61.4%	57.9%	44.3%	27.1%	27.7%	23.5%	20.2%	15.3%	9.3%	7.2%	−2.3%	22.5%
51	Pilbara	68.9%	56.9%	53.9%	90.3%	85.6%	74.7%	68.4%	75.1%	74.7%	63.8%	48.9%	55.5%	60.9%	69.1%	74.3%	62.7%	58.9%	−41.0%	65.2%
52	Kimberley	62.9%	48.5%	45.9%	86.7%	80.2%	70.0%	66.1%	72.7%	73.3%	61.7%	44.6%	51.4%	47.6%	47.0%	42.2%	41.2%	32.4%	−9.5%	50.6%
53	Greater-Hobart	2.3%	1.4%	1.0%	5.8%	4.5%	3.4%	2.8%	3.5%	3.0%	1.7%	0.8%	0.8%	0.6%	0.6%	0.4%	0.2%	0.1%	0.0%	0.5%
54	Southern	13.7%	8.0%	5.7%	33.6%	33.3%	24.3%	17.3%	18.7%	16.1%	8.9%	4.1%	3.8%	2.7%	2.6%	1.8%	1.3%	0.8%	−0.3%	3.2%
55	Northern (TAS)	6.6%	3.6%	2.5%	15.8%	13.4%	10.1%	8.1%	9.3%	8.1%	4.5%	2.2%	2.1%	1.6%	1.4%	0.9%	0.5%	0.3%	−0.1%	1.3%
56	Mersey-Lyell	20.0%	12.0%	8.5%	42.4%	41.4%	30.8%	25.4%	28.3%	24.1%	15.4%	7.6%	7.7%	5.6%	4.7%	3.1%	2.0%	1.1%	−0.3%	4.7%
57	Darwin	3.0%	2.0%	1.4%	9.8%	6.4%	3.9%	3.2%	4.4%	4.0%	2.5%	1.2%	1.3%	1.2%	1.3%	1.2%	0.9%	0.7%	−0.2%	1.6%
58	Northern-Territory	55.2%	40.1%	34.7%	79.9%	74.6%	65.0%	61.1%	67.8%	67.3%	56.1%	39.4%	43.5%	41.0%	44.8%	47.1%	36.9%	32.7%	−15.1%	48.2%
59	Canberra	0.7%	0.4%	0.3%	1.8%	1.1%	0.8%	0.7%	1.0%	0.9%	0.5%	0.3%	0.3%	0.2%	0.2%	0.2%	0.1%	0.0%	0.0%	0.2%
	Total	10.4%	6.2%	4.4%	24.1%	18.7%	13.1%	11.0%	13.9%	12.6%	7.7%	3.9%	3.9%	3.1%	2.7%	1.8%	1.0%	0.6%	−0.1%	2.5%

Table A2. Proximity Effects—Females.

SD	Statistical Division	1–5	6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75	76–80	81–85	≥ 86	Total
1	Sydney	1.5%	0.1%	1.1%	2.4%	1.4%	1.8%	1.9%	2.1%	2.2%	1.5%	0.9%	0.9%	0.6%	0.7%	0.5%	0.2%	0.1%	0.0%	0.3%
2	Hunter	11.2%	0.8%	6.9%	14.8%	11.0%	15.3%	15.8%	15.6%	15.1%	10.0%	6.4%	6.0%	3.8%	4.1%	2.6%	1.2%	0.5%	0.0%	1.8%
3	Illawarra	4.8%	0.3%	2.8%	6.5%	4.9%	7.1%	7.1%	6.9%	6.3%	4.1%	2.6%	2.5%	1.5%	1.5%	1.0%	0.5%	0.2%	0.0%	0.7%
4	Richmond-Tweed	5.1%	0.3%	2.7%	6.4%	5.9%	8.1%	7.6%	6.8%	6.1%	3.7%	2.2%	2.3%	1.5%	1.5%	0.9%	0.4%	0.2%	0.0%	0.6%
5	Mid-North-Coast	15.9%	1.0%	7.9%	18.4%	19.4%	24.3%	22.9%	20.3%	18.0%	11.4%	7.3%	6.8%	4.0%	4.2%	2.7%	1.4%	0.6%	0.0%	2.0%
6	Northern	16.2%	1.2%	10.2%	21.8%	18.6%	25.0%	25.3%	24.5%	23.2%	15.8%	10.5%	9.8%	6.2%	6.4%	4.5%	2.3%	1.0%	−0.1%	3.2%
7	North-Western	26.4%	2.2%	18.5%	38.7%	32.7%	38.7%	40.2%	38.3%	38.0%	27.9%	19.6%	18.6%	12.4%	13.2%	8.9%	5.0%	2.2%	−0.2%	7.0%
8	Central-West	12.3%	0.8%	7.3%	16.1%	13.6%	18.9%	18.9%	18.3%	17.2%	11.9%	7.5%	7.0%	4.4%	4.8%	3.1%	1.6%	0.7%	−0.1%	2.2%
9	South-Eastern	14.7%	1.0%	8.2%	19.4%	17.7%	21.9%	20.9%	18.4%	17.8%	11.9%	7.6%	7.1%	4.4%	5.0%	3.5%	1.8%	0.8%	−0.1%	2.6%
10	Murrumbidgee	11.7%	0.8%	7.3%	16.0%	12.8%	17.6%	18.3%	18.4%	17.6%	12.1%	7.9%	7.9%	5.1%	5.1%	3.4%	1.7%	0.7%	−0.1%	2.4%
11	Murray	19.4%	1.5%	12.0%	25.4%	21.0%	27.5%	28.5%	26.8%	26.1%	17.2%	11.4%	11.1%	7.1%	7.2%	4.9%	2.4%	1.0%	−0.1%	3.5%
12	Far-West	46.1%	5.0%	33.3%	57.5%	51.9%	58.4%	58.4%	57.9%	55.1%	41.3%	30.8%	29.8%	20.8%	21.0%	13.3%	6.5%	3.6%	−0.2%	9.9%
13	Melbourne	1.1%	0.1%	0.7%	1.6%	0.9%	1.2%	1.3%	1.3%	1.5%	1.0%	0.6%	0.6%	0.4%	0.5%	0.3%	0.1%	0.1%	0.0%	0.2%
14	Barwon	5.3%	0.3%	3.1%	6.9%	5.2%	7.2%	7.3%	7.0%	6.8%	4.4%	2.7%	2.6%	1.7%	1.8%	1.1%	0.5%	0.2%	0.0%	0.8%
15	Western-District	20.7%	1.5%	12.6%	26.0%	24.9%	30.1%	30.6%	28.2%	26.3%	18.5%	12.3%	12.1%	8.0%	8.2%	5.3%	2.6%	1.0%	−0.1%	3.5%
16	Centra-	5.1%	0.3%	2.9%	6.1%	4.7%	7.1%	7.4%	6.7%	6.6%	4.3%	2.6%	2.6%	1.7%	1.9%	1.2%	0.5%	0.2%	0.0%	0.8%
17	Wimmera	25.1%	1.8%	14.3%	32.3%	31.5%	34.3%	35.0%	31.9%	30.5%	20.8%	13.8%	13.3%	8.1%	8.3%	5.3%	2.4%	1.0%	−0.1%	3.4%
18	Mallee	31.9%	2.5%	19.0%	38.6%	35.9%	41.0%	42.2%	40.3%	39.2%	29.1%	20.7%	19.8%	13.2%	13.4%	8.9%	4.3%	1.8%	−0.2%	6.2%
19	Loddon	5.6%	0.3%	3.0%	7.1%	5.8%	8.9%	8.7%	7.7%	7.1%	4.6%	2.8%	2.7%	1.8%	2.0%	1.3%	0.6%	0.3%	0.0%	0.9%
20	Goulburn	8.4%	0.5%	4.5%	11.0%	10.0%	12.5%	12.2%	11.0%	10.6%	7.2%	4.4%	4.2%	2.7%	3.0%	1.9%	1.0%	0.4%	0.0%	1.3%
21	Ovens-Murray	17.9%	1.2%	10.5%	22.6%	20.5%	25.6%	25.3%	23.3%	22.1%	14.9%	9.9%	9.6%	6.4%	7.2%	4.7%	2.3%	1.0%	−0.1%	3.2%
22	East-Gippsland	17.3%	1.2%	9.5%	21.0%	20.6%	25.7%	25.6%	23.3%	21.4%	13.6%	8.2%	7.6%	4.9%	5.0%	3.5%	1.8%	0.8%	−0.1%	2.6%
23	Gippsland	6.5%	0.4%	3.5%	8.4%	7.0%	10.0%	10.0%	9.2%	8.5%	5.4%	3.3%	3.1%	1.9%	2.1%	1.4%	0.7%	0.3%	0.0%	1.0%
24	Brisbane	2.7%	0.2%	1.7%	3.7%	2.2%	3.2%	3.5%	3.6%	3.8%	2.6%	1.6%	1.6%	1.1%	1.4%	0.9%	0.4%	0.2%	0.0%	0.6%
25	Gold-Coast	1.4%	0.1%	0.9%	2.0%	1.2%	1.7%	1.8%	1.8%	1.8%	1.2%	0.7%	0.7%	0.4%	0.5%	0.4%	0.2%	0.1%	0.0%	0.2%
26	Sunshine-Coast	2.9%	0.2%	1.5%	3.8%	3.1%	4.3%	4.0%	3.6%	3.2%	2.1%	1.3%	1.2%	0.7%	0.8%	0.6%	0.3%	0.1%	0.0%	0.4%
27	West-Moreton	8.4%	0.4%	4.0%	10.4%	9.8%	12.9%	12.1%	10.5%	9.8%	6.7%	4.2%	3.7%	2.4%	2.8%	2.1%	1.2%	0.5%	0.0%	1.6%
28	Wide-Bay-Burnett	13.5%	0.8%	7.4%	18.6%	16.2%	20.3%	20.3%	18.0%	16.8%	11.3%	6.9%	6.0%	3.6%	4.0%	2.9%	1.6%	0.7%	−0.1%	2.3%
29	Darling	10.2%	0.7%	6.4%	14.7%	11.3%	16.0%	16.5%	15.9%	15.8%	10.5%	6.8%	6.5%	4.1%	4.6%	3.0%	1.6%	0.7%	0.0%	2.1%
30	South-West	40.3%	4.0%	33.5%	61.5%	44.6%	52.3%	52.4%	52.0%	52.3%	42.8%	35.2%	33.8%	25.1%	24.8%	19.6%	11.1%	5.7%	−0.5%	15.5%

Table A2. Cont.

SD	Statistical Division	1–5	6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75	76–80	81–85	≥ 86	Total
31	Fitzroy	14.5%	1.0%	9.0%	20.6%	15.5%	20.2%	21.0%	21.3%	20.5%	14.8%	10.3%	10.8%	7.4%	8.3%	5.7%	3.1%	1.4%	−0.1%	4.2%
32	Central-West	53.3%	5.8%	43.1%	65.3%	48.7%	56.6%	62.6%	61.7%	59.5%	51.7%	39.3%	41.1%	29.4%	30.9%	24.6%	14.7%	7.3%	−0.7%	20.0%
33	Mackay	29.4%	2.5%	19.6%	39.6%	29.7%	36.1%	37.4%	37.0%	36.5%	27.6%	20.1%	21.0%	15.7%	19.0%	13.4%	7.7%	3.7%	−0.3%	10.1%
34	Northern	33.9%	3.3%	23.9%	42.4%	32.1%	40.8%	43.5%	44.2%	44.7%	34.8%	25.8%	26.0%	19.3%	21.8%	15.8%	8.6%	3.9%	−0.3%	11.6%
35	Far-	20.3%	1.6%	14.1%	30.9%	24.0%	27.5%	28.0%	27.8%	28.0%	20.5%	14.2%	14.8%	10.5%	13.0%	9.9%	5.4%	2.4%	−0.2%	7.0%
36	North-West	47.4%	5.9%	43.1%	68.0%	51.2%	56.4%	60.8%	65.2%	66.9%	58.4%	49.9%	51.4%	41.7%	53.5%	41.9%	28.1%	18.0%	−1.7%	34.9%
37	Adelaide	0.5%	0.0%	0.3%	0.7%	0.4%	0.6%	0.7%	0.7%	0.7%	0.4%	0.3%	0.2%	0.2%	0.2%	0.1%	0.0%	0.0%	0.0%	0.1%
38	Outer-Adelaide	12.1%	0.7%	6.4%	15.1%	14.3%	18.3%	16.1%	14.0%	13.2%	9.0%	5.7%	5.2%	3.3%	3.9%	2.7%	1.3%	0.6%	0.0%	1.8%
39	Yorke	20.6%	1.4%	11.0%	27.3%	26.9%	31.2%	30.7%	24.8%	23.2%	15.5%	9.7%	8.5%	4.7%	5.3%	3.4%	1.8%	0.8%	−0.1%	2.5%
40	Murray-Lands	21.0%	1.5%	12.0%	28.9%	25.0%	29.6%	29.8%	26.7%	25.8%	18.4%	11.7%	10.5%	7.4%	7.5%	5.2%	2.7%	1.0%	−0.1%	3.6%
41	South-East	29.6%	2.4%	19.6%	40.2%	34.0%	39.0%	40.6%	37.5%	38.0%	27.6%	19.4%	20.2%	13.4%	14.0%	10.0%	5.0%	2.2%	−0.2%	6.8%
42	Eyre	40.1%	3.5%	26.8%	50.9%	44.8%	48.9%	49.8%	47.9%	47.6%	35.3%	26.0%	25.2%	16.8%	20.2%	14.6%	6.6%	3.0%	−0.2%	9.4%
43	Northern	38.8%	3.5%	25.8%	49.7%	42.0%	47.8%	48.9%	47.4%	47.5%	37.3%	26.5%	25.5%	17.2%	19.1%	13.6%	7.2%	3.5%	−0.3%	10.3%
44	Perth	1.2%	0.1%	0.8%	1.6%	1.0%	1.5%	1.6%	1.6%	1.6%	1.1%	0.6%	0.7%	0.5%	0.5%	0.3%	0.2%	0.1%	0.0%	0.2%
45	South-West	19.6%	1.4%	11.4%	25.1%	22.9%	27.8%	26.8%	24.5%	23.6%	16.6%	11.1%	10.4%	6.7%	7.1%	5.0%	2.6%	1.3%	−0.1%	4.0%
46	Lower	35.1%	3.2%	24.1%	46.4%	44.4%	48.5%	48.8%	44.9%	43.6%	32.0%	23.1%	22.9%	15.8%	16.7%	11.9%	6.4%	2.9%	−0.2%	9.0%
47	Upper-Great-Southern	24.0%	1.9%	17.8%	41.0%	32.6%	36.5%	39.1%	34.5%	36.8%	23.4%	16.4%	15.6%	11.6%	11.3%	9.0%	5.4%	1.9%	−0.1%	6.0%
48	Midlands	23.2%	1.7%	15.3%	38.6%	32.0%	35.8%	33.4%	30.7%	30.0%	21.1%	13.2%	12.4%	8.3%	9.4%	7.7%	4.5%	2.1%	−0.2%	6.0%
49	South-Eastern	43.8%	4.9%	36.5%	59.8%	49.3%	53.6%	55.1%	57.1%	58.5%	51.2%	40.7%	44.3%	37.1%	42.9%	35.2%	23.5%	12.2%	−1.1%	27.3%
50	Central	44.9%	4.5%	32.7%	58.5%	52.5%	56.0%	57.6%	55.8%	55.1%	45.0%	34.4%	35.0%	25.7%	28.7%	21.2%	14.2%	7.5%	−0.7%	18.8%
51	Pilbara	57.5%	9.1%	55.8%	77.9%	65.6%	67.7%	68.3%	71.5%	74.6%	68.5%	60.3%	68.1%	69.1%	80.3%	79.1%	73.3%	52.3%	−12.9%	64.7%
52	Kimberley	53.0%	7.3%	50.2%	71.1%	56.9%	62.5%	66.6%	68.5%	71.3%	63.8%	54.2%	60.3%	53.4%	63.7%	61.8%	47.9%	45.7%	−3.8%	50.3%
53	Greater-Hobart	2.0%	0.1%	1.3%	2.6%	1.8%	2.7%	2.9%	2.8%	2.7%	1.7%	1.0%	1.0%	0.7%	0.8%	0.5%	0.2%	0.1%	0.0%	0.3%
54	Southern	10.9%	0.7%	6.8%	17.5%	15.9%	18.6%	16.8%	14.8%	14.0%	8.8%	5.4%	4.6%	3.2%	4.0%	3.1%	1.9%	0.9%	−0.1%	2.5%
55	Northern	5.5%	0.4%	3.2%	7.6%	5.4%	8.0%	8.2%	7.6%	7.5%	4.7%	2.9%	2.7%	1.7%	1.9%	1.3%	0.6%	0.3%	0.0%	0.9%
56	Mersey-Lyell	18.0%	1.3%	10.7%	23.8%	20.5%	24.9%	25.6%	23.3%	23.0%	15.7%	10.1%	9.5%	6.1%	6.7%	4.5%	2.4%	0.9%	−0.1%	3.2%
57	Darwin	2.2%	0.2%	1.7%	4.2%	2.6%	2.9%	3.2%	3.4%	3.7%	2.5%	1.6%	1.8%	1.5%	2.3%	2.2%	1.3%	0.7%	−0.1%	1.5%
58	Northern-Territory	48.8%	5.8%	39.0%	61.5%	49.5%	56.5%	60.4%	62.6%	66.1%	56.8%	46.6%	53.0%	46.2%	56.7%	53.5%	43.2%	31.2%	−3.7%	44.3%
59	Canberra	0.6%	0.0%	0.4%	0.8%	0.4%	0.6%	0.7%	0.8%	0.8%	0.5%	0.3%	0.3%	0.2%	0.3%	0.2%	0.1%	0.0%	0.0%	0.1%
	Total	8.3%	0.6%	5.3%	11.5%	7.7%	10.2%	10.9%	10.9%	11.1%	7.5%	4.8%	4.7%	3.2%	3.6%	2.3%	1.1%	0.5%	0.0%	1.6%

Appendix D

Table A3. Proximity Effects per 10 km—Males.

SD	Statistical Division	1–5	6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75	76–80	81–85	≥ 86	Total
1	Sydney	0.6%	0.4%	0.3%	1.8%	1.2%	0.7%	0.6%	0.8%	0.8%	0.5%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.2%
2	Hunter	1.2%	0.7%	0.5%	2.6%	2.1%	1.6%	1.4%	1.7%	1.5%	0.9%	0.4%	0.4%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.2%
3	Illawarra	1.4%	0.7%	0.5%	3.2%	2.6%	2.0%	1.6%	2.0%	1.6%	0.9%	0.5%	0.5%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.2%
4	Richmond-Tweed	1.0%	0.5%	0.3%	2.2%	2.2%	1.7%	1.3%	1.4%	1.2%	0.6%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.2%
5	Mid-North Coast	3.0%	1.6%	1.0%	5.8%	6.2%	4.9%	3.8%	4.2%	3.4%	1.9%	0.9%	0.9%	0.6%	0.5%	0.3%	0.2%	0.1%	0.0%	0.5%
6	Northern (NSW)	1.0%	0.6%	0.4%	2.1%	1.9%	1.5%	1.3%	1.5%	1.3%	0.8%	0.4%	0.4%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.2%
7	North Western	0.8%	0.5%	0.4%	1.5%	1.4%	1.2%	1.0%	1.1%	1.0%	0.7%	0.4%	0.4%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.2%
8	Central West	1.0%	0.6%	0.4%	2.1%	2.0%	1.5%	1.2%	1.5%	1.3%	0.8%	0.4%	0.4%	0.3%	0.2%	0.1%	0.1%	0.1%	0.0%	0.2%
9	South Eastern	1.7%	1.0%	0.7%	3.6%	3.5%	2.6%	2.0%	2.3%	1.9%	1.1%	0.6%	0.5%	0.4%	0.3%	0.2%	0.1%	0.1%	0.0%	0.4%
10	Murrumbidgee	1.1%	0.6%	0.5%	2.3%	2.1%	1.6%	1.4%	1.6%	1.4%	0.9%	0.4%	0.5%	0.4%	0.3%	0.2%	0.1%	0.1%	0.0%	0.3%
11	Murray	1.4%	0.8%	0.6%	2.7%	2.6%	1.9%	1.7%	1.9%	1.7%	1.0%	0.5%	0.5%	0.4%	0.3%	0.2%	0.1%	0.1%	0.0%	0.3%
12	Far West	1.5%	1.1%	0.9%	2.3%	2.2%	2.0%	1.7%	1.9%	1.7%	1.2%	0.7%	0.7%	0.6%	0.5%	0.3%	0.2%	0.1%	0.0%	0.5%
13	Melbourne	0.5%	0.3%	0.2%	1.4%	1.0%	0.6%	0.5%	0.7%	0.6%	0.4%	0.2%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.1%
14	Barwon	0.8%	0.4%	0.3%	1.9%	1.6%	1.1%	0.9%	1.1%	1.0%	0.6%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.2%
15	Western District	3.9%	2.0%	1.4%	6.7%	6.5%	5.2%	4.2%	4.8%	4.1%	2.7%	1.3%	1.3%	1.1%	0.9%	0.5%	0.3%	0.2%	0.0%	0.8%
16	Central Highlands	0.7%	0.4%	0.3%	1.6%	1.4%	1.1%	0.9%	1.0%	0.9%	0.5%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.1%
17	Wimmera	2.6%	1.4%	1.0%	4.4%	4.3%	3.5%	2.9%	3.2%	2.7%	1.6%	0.9%	0.8%	0.7%	0.5%	0.3%	0.2%	0.1%	0.0%	0.5%
18	Mallee	2.0%	1.2%	0.9%	3.5%	3.4%	2.7%	2.4%	2.6%	2.4%	1.6%	0.9%	0.9%	0.7%	0.6%	0.4%	0.2%	0.1%	0.0%	0.5%
19	Loddon	1.0%	0.5%	0.3%	2.1%	2.0%	1.5%	1.2%	1.3%	1.1%	0.6%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.2%
20	Goulburn	1.3%	0.7%	0.5%	3.0%	3.0%	2.2%	1.6%	1.9%	1.6%	0.9%	0.5%	0.4%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.3%
21	Ovens-Murray	2.2%	1.3%	0.9%	4.1%	4.1%	3.2%	2.6%	3.0%	2.5%	1.6%	0.8%	0.8%	0.6%	0.5%	0.4%	0.2%	0.1%	0.0%	0.5%
22	East Gippsland	1.8%	1.0%	0.7%	3.5%	3.4%	2.5%	2.2%	2.4%	2.1%	1.2%	0.6%	0.5%	0.4%	0.3%	0.2%	0.1%	0.1%	0.0%	0.3%
23	Gippsland	1.5%	0.7%	0.5%	3.1%	3.0%	2.3%	1.8%	2.0%	1.7%	0.9%	0.4%	0.4%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.3%
24	Brisbane	1.3%	0.8%	0.6%	3.4%	2.3%	1.6%	1.4%	1.8%	1.7%	1.0%	0.5%	0.5%	0.4%	0.4%	0.3%	0.2%	0.1%	0.0%	0.4%
25	Gold Coast	0.8%	0.5%	0.3%	2.1%	1.4%	1.0%	0.8%	1.1%	1.0%	0.6%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.2%
26	Sunshine Coast	1.3%	0.7%	0.4%	3.1%	2.9%	2.0%	1.5%	1.8%	1.5%	0.8%	0.4%	0.4%	0.3%	0.2%	0.1%	0.1%	0.0%	0.0%	0.2%
27	West Moreton	1.3%	0.7%	0.5%	3.2%	3.2%	2.4%	1.7%	1.9%	1.5%	0.9%	0.4%	0.4%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.3%
28	Wide Bay-Burnett	1.2%	0.6%	0.4%	2.5%	2.4%	1.8%	1.4%	1.6%	1.4%	0.8%	0.4%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.2%
29	Darling Downs	0.6%	0.4%	0.3%	1.5%	1.2%	1.0%	0.8%	1.0%	0.9%	0.5%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.2%
30	South West	0.8%	0.6%	0.5%	1.4%	1.3%	1.1%	1.0%	1.1%	1.0%	0.7%	0.5%	0.5%	0.4%	0.4%	0.2%	0.2%	0.1%	0.0%	0.4%

Table A3. Cont.

SD	Statistical Division	1–5	6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75	76–80	81–85	≥ 86	Total
31	Fitzroy	0.7%	0.4%	0.3%	1.5%	1.3%	0.9%	0.8%	1.0%	0.9%	0.5%	0.3%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.2%
32	Central West	0.8%	0.6%	0.6%	1.2%	1.1%	1.0%	0.9%	1.0%	0.9%	0.7%	0.4%	0.5%	0.4%	0.3%	0.2%	0.1%	0.1%	0.0%	0.3%
33	Mackay	1.2%	0.8%	0.6%	2.2%	1.9%	1.5%	1.3%	1.5%	1.4%	0.9%	0.5%	0.6%	0.5%	0.5%	0.4%	0.2%	0.1%	0.0%	0.5%
34	Northern	1.6%	1.0%	0.8%	2.5%	2.1%	1.8%	1.6%	1.9%	1.8%	1.3%	0.8%	0.8%	0.7%	0.6%	0.5%	0.3%	0.2%	0.0%	0.6%
35	Far North	0.4%	0.3%	0.2%	1.0%	0.8%	0.6%	0.5%	0.6%	0.6%	0.4%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.2%
36	North West	1.3%	1.0%	0.9%	1.9%	1.7%	1.5%	1.4%	1.6%	1.6%	1.3%	0.9%	1.0%	0.8%	0.9%	0.7%	0.6%	0.4%	−0.1%	0.9%
37	Adelaide	0.5%	0.3%	0.2%	1.1%	0.8%	0.6%	0.5%	0.6%	0.5%	0.3%	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.1%
38	Outer Adelaide	1.2%	0.6%	0.4%	2.4%	2.4%	1.8%	1.4%	1.5%	1.2%	0.7%	0.4%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.0%	0.2%
39	Yorke and Lower North	1.7%	0.9%	0.7%	3.2%	3.2%	2.5%	2.1%	2.2%	1.8%	1.1%	0.5%	0.5%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.3%
40	Murray Lands	1.4%	0.8%	0.6%	2.7%	2.6%	2.0%	1.6%	1.7%	1.6%	1.0%	0.5%	0.5%	0.4%	0.3%	0.2%	0.1%	0.1%	0.0%	0.3%
41	South East	3.8%	2.3%	1.7%	6.3%	5.8%	4.6%	4.1%	4.4%	4.0%	2.7%	1.5%	1.6%	1.3%	1.2%	0.8%	0.4%	0.3%	−0.1%	1.1%
42	Eyre	0.9%	0.6%	0.4%	1.4%	1.3%	1.1%	0.9%	1.0%	1.0%	0.7%	0.4%	0.4%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.3%
43	Northern (QLD)	0.6%	0.4%	0.3%	1.0%	1.0%	0.8%	0.7%	0.8%	0.7%	0.5%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%	0.1%	0.0%	0.2%
44	Perth	0.6%	0.3%	0.2%	1.3%	1.0%	0.7%	0.6%	0.7%	0.7%	0.4%	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%	0.0%	0.0%	0.1%
45	South West	1.9%	1.1%	0.7%	3.7%	3.6%	2.7%	2.2%	2.5%	2.2%	1.4%	0.7%	0.7%	0.5%	0.4%	0.3%	0.2%	0.1%	0.0%	0.4%
46	Lower Great Southern	2.2%	1.4%	1.1%	3.4%	3.4%	2.8%	2.5%	2.7%	2.4%	1.7%	0.9%	0.9%	0.8%	0.6%	0.4%	0.3%	0.2%	0.0%	0.6%
47	Upper Great Southern	0.9%	0.6%	0.5%	1.9%	1.7%	1.3%	1.1%	1.2%	1.1%	0.7%	0.4%	0.4%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.3%
48	Midlands	0.9%	0.5%	0.4%	1.8%	1.8%	1.4%	1.1%	1.2%	1.0%	0.7%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%	0.1%	0.0%	0.2%
49	South Eastern	0.7%	0.5%	0.5%	1.1%	1.0%	0.8%	0.8%	0.8%	0.8%	0.7%	0.4%	0.5%	0.4%	0.4%	0.4%	0.3%	0.2%	−0.1%	0.5%
50	Central	0.7%	0.5%	0.4%	1.1%	1.1%	0.9%	0.8%	0.9%	0.8%	0.6%	0.4%	0.4%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.3%
51	Pilbara	0.9%	0.8%	0.7%	1.2%	1.2%	1.0%	0.9%	1.0%	1.0%	0.9%	0.7%	0.8%	0.8%	0.9%	1.0%	0.9%	0.8%	−0.6%	0.9%
52	Kimberley	0.6%	0.5%	0.4%	0.8%	0.8%	0.7%	0.6%	0.7%	0.7%	0.6%	0.4%	0.5%	0.5%	0.5%	0.4%	0.4%	0.3%	−0.1%	0.5%
53	Greater Hobart	0.9%	0.5%	0.4%	2.2%	1.7%	1.3%	1.1%	1.3%	1.2%	0.6%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.2%
54	Southern	1.2%	0.7%	0.5%	2.8%	2.8%	2.0%	1.5%	1.6%	1.4%	0.8%	0.3%	0.3%	0.2%	0.2%	0.2%	0.1%	0.1%	0.0%	0.3%
55	Northern (TAS)	0.6%	0.3%	0.2%	1.4%	1.2%	0.9%	0.7%	0.9%	0.7%	0.4%	0.2%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.1%
56	Mersey-Lyell	1.3%	0.8%	0.6%	2.8%	2.7%	2.0%	1.7%	1.9%	1.6%	1.0%	0.5%	0.5%	0.4%	0.3%	0.2%	0.1%	0.1%	0.0%	0.3%
57	Darwin	0.5%	0.3%	0.2%	1.6%	1.0%	0.6%	0.5%	0.7%	0.7%	0.4%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.0%	0.3%
58	Northern Territory - Bal	1.0%	0.8%	0.7%	1.5%	1.4%	1.2%	1.1%	1.3%	1.3%	1.1%	0.7%	0.8%	0.8%	0.8%	0.9%	0.7%	0.6%	−0.3%	0.9%
59	Canberra	0.4%	0.3%	0.2%	1.1%	0.7%	0.5%	0.4%	0.6%	0.6%	0.3%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.1%

Table A4. Proximity Effects per 10 km—Females.

SD	Statistical Division	1–5	6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75	76–80	81–85	≥86	Total
1	Sydney	0.5%	0.0%	0.4%	0.8%	0.5%	0.6%	0.6%	0.7%	0.7%	0.5%	0.3%	0.3%	0.2%	0.2%	0.2%	0.1%	0.0%	0.0%	0.1%
2	Hunter	1.0%	0.1%	0.6%	1.3%	1.0%	1.4%	1.4%	1.4%	1.4%	0.9%	0.6%	0.5%	0.3%	0.4%	0.2%	0.1%	0.0%	0.0%	0.2%
3	Illawarra	1.1%	0.1%	0.6%	1.5%	1.1%	1.6%	1.6%	1.6%	1.5%	1.0%	0.6%	0.6%	0.3%	0.3%	0.2%	0.1%	0.0%	0.0%	0.2%
4	Richmond-Tweed	0.9%	0.1%	0.4%	1.1%	1.0%	1.3%	1.3%	1.1%	1.0%	0.6%	0.4%	0.4%	0.2%	0.3%	0.2%	0.1%	0.0%	0.0%	0.1%
5	Mid-North Coast	2.7%	0.2%	1.3%	3.1%	3.2%	4.1%	3.8%	3.4%	3.0%	1.9%	1.2%	1.1%	0.7%	0.7%	0.4%	0.2%	0.1%	0.0%	0.3%
6	Northern	0.8%	0.1%	0.5%	1.1%	1.0%	1.3%	1.3%	1.3%	1.2%	0.8%	0.5%	0.5%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.2%
7	North Western	0.7%	0.1%	0.5%	1.0%	0.8%	1.0%	1.0%	1.0%	0.9%	0.7%	0.5%	0.5%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.2%
8	Central West	0.8%	0.1%	0.5%	1.1%	0.9%	1.3%	1.3%	1.2%	1.2%	0.8%	0.5%	0.5%	0.3%	0.3%	0.2%	0.1%	0.0%	0.0%	0.1%
9	South Eastern	1.4%	0.1%	0.8%	1.9%	1.7%	2.1%	2.1%	1.8%	1.7%	1.2%	0.7%	0.7%	0.4%	0.5%	0.3%	0.2%	0.1%	0.0%	0.3%
10	Murrumbidgee	0.9%	0.1%	0.6%	1.2%	1.0%	1.3%	1.4%	1.4%	1.3%	0.9%	0.6%	0.6%	0.4%	0.4%	0.3%	0.1%	0.1%	0.0%	0.2%
11	Murray	1.2%	0.1%	0.7%	1.5%	1.3%	1.7%	1.7%	1.6%	1.6%	1.0%	0.7%	0.7%	0.4%	0.4%	0.3%	0.1%	0.1%	0.0%	0.2%
12	Far West	1.4%	0.2%	1.0%	1.7%	1.6%	1.8%	1.8%	1.7%	1.7%	1.2%	0.9%	0.9%	0.6%	0.6%	0.4%	0.2%	0.1%	0.0%	0.3%
13	Melbourne	0.4%	0.0%	0.3%	0.6%	0.4%	0.5%	0.5%	0.6%	0.6%	0.4%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.1%
14	Barwon	0.7%	0.0%	0.4%	0.9%	0.7%	0.9%	0.9%	0.9%	0.9%	0.6%	0.4%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.1%
15	Western District	3.0%	0.2%	1.8%	3.8%	3.6%	4.4%	4.4%	4.1%	3.8%	2.7%	1.8%	1.8%	1.2%	1.2%	0.8%	0.4%	0.1%	0.0%	0.5%
16	Central Highlands	0.6%	0.0%	0.3%	0.7%	0.6%	0.9%	0.9%	0.8%	0.8%	0.5%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.1%
17	Wimmera	2.1%	0.2%	1.2%	2.7%	2.7%	2.9%	3.0%	2.7%	2.6%	1.8%	1.2%	1.1%	0.7%	0.7%	0.5%	0.2%	0.1%	0.0%	0.3%
18	Mallee	1.8%	0.1%	1.1%	2.2%	2.1%	2.4%	2.4%	2.3%	2.2%	1.7%	1.2%	1.1%	0.8%	0.8%	0.5%	0.2%	0.1%	0.0%	0.4%
19	Loddon	0.8%	0.0%	0.4%	1.0%	0.8%	1.2%	1.2%	1.1%	1.0%	0.6%	0.4%	0.4%	0.3%	0.3%	0.2%	0.1%	0.0%	0.0%	0.1%
20	Goulburn	1.1%	0.1%	0.6%	1.5%	1.4%	1.7%	1.7%	1.5%	1.4%	1.0%	0.6%	0.6%	0.4%	0.4%	0.3%	0.1%	0.1%	0.0%	0.2%
21	Ovens-Murray	1.9%	0.1%	1.1%	2.4%	2.2%	2.7%	2.7%	2.5%	2.3%	1.6%	1.0%	1.0%	0.7%	0.8%	0.5%	0.2%	0.1%	0.0%	0.3%
22	East Gippsland	1.5%	0.1%	0.8%	1.8%	1.8%	2.2%	2.2%	2.0%	1.9%	1.2%	0.7%	0.7%	0.4%	0.4%	0.3%	0.2%	0.1%	0.0%	0.2%
23	Gippsland	1.2%	0.1%	0.6%	1.5%	1.2%	1.8%	1.8%	1.6%	1.5%	1.0%	0.6%	0.6%	0.3%	0.4%	0.2%	0.1%	0.1%	0.0%	0.2%
24	Brisbane	1.1%	0.1%	0.7%	1.5%	0.9%	1.3%	1.4%	1.5%	1.5%	1.0%	0.7%	0.6%	0.5%	0.6%	0.4%	0.2%	0.1%	0.0%	0.2%
25	Gold Coast	0.7%	0.0%	0.4%	0.9%	0.6%	0.8%	0.8%	0.9%	0.9%	0.6%	0.3%	0.3%	0.2%	0.2%	0.2%	0.1%	0.0%	0.0%	0.1%
26	Sunshine Coast	1.1%	0.1%	0.6%	1.4%	1.2%	1.6%	1.5%	1.4%	1.2%	0.8%	0.5%	0.5%	0.3%	0.3%	0.2%	0.1%	0.0%	0.0%	0.2%
27	West Moreton	1.2%	0.1%	0.6%	1.5%	1.4%	1.8%	1.7%	1.5%	1.4%	1.0%	0.6%	0.5%	0.3%	0.4%	0.3%	0.2%	0.1%	0.0%	0.2%
28	Wide Bay-Burnett	1.0%	0.1%	0.5%	1.3%	1.1%	1.4%	1.4%	1.3%	1.2%	0.8%	0.5%	0.4%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.2%
29	Darling Downs	0.5%	0.0%	0.3%	0.7%	0.6%	0.8%	0.8%	0.8%	0.8%	0.5%	0.3%	0.3%	0.2%	0.2%	0.2%	0.1%	0.0%	0.0%	0.1%
30	South West	0.7%	0.1%	0.6%	1.1%	0.8%	0.9%	0.9%	0.9%	0.9%	0.8%	0.6%	0.6%	0.5%	0.4%	0.4%	0.2%	0.1%	0.0%	0.3%

Table A4. Cont.

SD	Statistical Division	1–5	6–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75	76–80	81–85	≥86	Total
31	Fitzroy	0.6%	0.0%	0.3%	0.8%	0.6%	0.8%	0.8%	0.8%	0.8%	0.6%	0.4%	0.4%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.2%
32	Central West	0.8%	0.1%	0.6%	1.0%	0.7%	0.8%	0.9%	0.9%	0.9%	0.8%	0.6%	0.6%	0.4%	0.5%	0.4%	0.2%	0.1%	0.0%	0.3%
33	Mackay	1.0%	0.1%	0.7%	1.4%	1.1%	1.3%	1.3%	1.3%	1.3%	1.0%	0.7%	0.7%	0.6%	0.7%	0.5%	0.3%	0.1%	0.0%	0.4%
34	Northern	1.3%	0.1%	0.9%	1.6%	1.2%	1.6%	1.7%	1.7%	1.7%	1.3%	1.0%	1.0%	0.7%	0.8%	0.6%	0.3%	0.2%	0.0%	0.4%
35	Far North	0.4%	0.0%	0.3%	0.6%	0.4%	0.5%	0.5%	0.5%	0.5%	0.4%	0.3%	0.3%	0.2%	0.2%	0.2%	0.1%	0.0%	0.0%	0.1%
36	North West	1.1%	0.1%	1.0%	1.6%	1.2%	1.3%	1.4%	1.5%	1.5%	1.3%	1.1%	1.2%	1.0%	1.2%	1.0%	0.6%	0.4%	0.0%	0.8%
37	Adelaide	0.4%	0.0%	0.2%	0.5%	0.3%	0.5%	0.5%	0.5%	0.5%	0.3%	0.2%	0.2%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.1%
38	Outer Adelaide	1.0%	0.1%	0.5%	1.3%	1.2%	1.5%	1.3%	1.2%	1.1%	0.8%	0.5%	0.4%	0.3%	0.3%	0.2%	0.1%	0.0%	0.0%	0.2%
39	Yorke and Lower North	1.5%	0.1%	0.8%	1.9%	1.9%	2.2%	2.2%	1.8%	1.6%	1.1%	0.7%	0.6%	0.3%	0.4%	0.2%	0.1%	0.1%	0.0%	0.2%
40	Murray Lands	1.2%	0.1%	0.7%	1.6%	1.4%	1.7%	1.7%	1.5%	1.5%	1.0%	0.7%	0.6%	0.4%	0.4%	0.3%	0.2%	0.1%	0.0%	0.2%
41	South East	3.0%	0.3%	2.0%	4.1%	3.5%	4.0%	4.2%	3.9%	3.9%	2.8%	2.0%	2.1%	1.4%	1.4%	1.0%	0.5%	0.2%	0.0%	0.7%
42	Eyre	0.8%	0.1%	0.5%	1.0%	0.9%	0.9%	1.0%	0.9%	0.9%	0.7%	0.5%	0.5%	0.3%	0.4%	0.3%	0.1%	0.1%	0.0%	0.2%
43	Northern	0.6%	0.1%	0.4%	0.7%	0.6%	0.7%	0.7%	0.7%	0.7%	0.5%	0.4%	0.4%	0.2%	0.3%	0.2%	0.1%	0.0%	0.0%	0.1%
44	Perth	0.5%	0.0%	0.3%	0.6%	0.4%	0.5%	0.6%	0.6%	0.6%	0.4%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.1%
45	South West	1.6%	0.1%	0.9%	2.1%	1.9%	2.3%	2.2%	2.0%	2.0%	1.4%	0.9%	0.9%	0.6%	0.6%	0.4%	0.2%	0.1%	0.0%	0.3%
46	Lower Great Southern	1.8%	0.2%	1.2%	2.4%	2.3%	2.5%	2.5%	2.3%	2.2%	1.6%	1.2%	1.2%	0.8%	0.9%	0.6%	0.3%	0.1%	0.0%	0.5%
47	Upper Great Southern	0.7%	0.1%	0.5%	1.3%	1.0%	1.1%	1.2%	1.1%	1.1%	0.7%	0.5%	0.5%	0.4%	0.3%	0.3%	0.2%	0.1%	0.0%	0.2%
48	Midlands	0.7%	0.1%	0.5%	1.2%	1.0%	1.2%	1.1%	1.0%	1.0%	0.7%	0.4%	0.4%	0.3%	0.3%	0.2%	0.1%	0.1%	0.0%	0.2%
49	South Eastern	0.6%	0.1%	0.5%	0.8%	0.7%	0.7%	0.8%	0.8%	0.8%	0.7%	0.6%	0.6%	0.5%	0.6%	0.5%	0.3%	0.2%	0.0%	0.4%
50	Central	0.6%	0.1%	0.5%	0.8%	0.7%	0.8%	0.8%	0.8%	0.8%	0.6%	0.5%	0.5%	0.4%	0.4%	0.3%	0.2%	0.1%	0.0%	0.3%
51	Pilbara	0.8%	0.1%	0.8%	1.1%	0.9%	0.9%	0.9%	1.0%	1.0%	0.9%	0.8%	0.9%	0.9%	1.1%	1.1%	1.0%	0.7%	−0.2%	0.9%
52	Kimberley	0.5%	0.1%	0.5%	0.7%	0.5%	0.6%	0.6%	0.7%	0.7%	0.6%	0.5%	0.6%	0.5%	0.6%	0.6%	0.5%	0.4%	0.0%	0.5%
53	Greater Hobart	0.8%	0.1%	0.5%	1.0%	0.7%	1.0%	1.1%	1.1%	1.0%	0.6%	0.4%	0.4%	0.3%	0.3%	0.2%	0.1%	0.0%	0.0%	0.1%
54	Southern	0.9%	0.1%	0.6%	1.5%	1.3%	1.6%	1.4%	1.2%	1.2%	0.7%	0.5%	0.4%	0.3%	0.3%	0.3%	0.2%	0.1%	0.0%	0.2%
55	Northern	0.5%	0.0%	0.3%	0.7%	0.5%	0.7%	0.7%	0.7%	0.7%	0.4%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.1%
56	Mersey-Lyell	1.2%	0.1%	0.7%	1.6%	1.4%	1.6%	1.7%	1.5%	1.5%	1.0%	0.7%	0.6%	0.4%	0.4%	0.3%	0.2%	0.1%	0.0%	0.2%
57	Darwin	0.4%	0.0%	0.3%	0.7%	0.4%	0.5%	0.5%	0.6%	0.6%	0.4%	0.3%	0.3%	0.3%	0.4%	0.4%	0.2%	0.1%	0.0%	0.2%
58	Northern Territory - Bal	0.9%	0.1%	0.7%	1.2%	0.9%	1.1%	1.1%	1.2%	1.2%	1.1%	0.9%	1.0%	0.9%	1.1%	1.0%	0.8%	0.6%	−0.1%	0.8%
59	Canberra	0.4%	0.0%	0.2%	0.5%	0.3%	0.4%	0.5%	0.5%	0.5%	0.3%	0.2%	0.2%	0.1%	0.2%	0.1%	0.1%	0.0%	0.0%	0.1%

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