Title

Rural Amenity and Medical Workforce Shortage: Is there a Relationship?

Abstract

Rural Australia continues to experience a chronic medical workforce shortage. For a variety of reasons, recruiting to and retaining medical professionals in many rural communities remain difficult. A place's amenity is often cited as a significant contributing factor towards the differential attractiveness of different rural and remote practice locations for doctors. This study investigates the extent to which there is an association between medical workforce shortage across rural Australia and a selection of place characteristics descriptive of their isolation, climate, and overall rural amenity. Our main outcome measure, District of Workforce Shortage (DWS) designation, has been employed for over a decade to identify areas eligible for incentive measures designed to overcome the chronic rural medical workforce shortage. Somewhat surprisingly, our study found only a weak association between DWS and our measure of rural amenity. In contrast, alternative measures of medical workforce shortage showed a moderate-to-strong association with rural amenity. The weak explanatory value of rural amenity may reflect the limitations of the DWS measure or the lesser significance of rural amenity compared to other professional aspects relating to where doctors take up practice. Findings from this study also suggest that the current DWS measure provides an inadequate basis for targeting recruitment and retention incentives.

Keywords

Rural amenity; place attraction; rural health; medical workforce; doctor shortage; recruitment and retention

Acronyms used

DWS: District of Workforce Shortage (designation used by Australian Government for health policy implementation)

SLA: Statistical Local Area

DoHA: Australian Government Department of Health and Ageing

UCL: Urban Centre / Locality

PPR: Population to Provider Ratio (measure of medical workforce supply vs demand)

AMPCo: Australasian Medical Publishing Company (providers of health care information including Medical Directory of Australia)

Introduction

Compounding the undersupply of health and medical practitioners in Australia is the longstanding problem of the maldistribution of the health workforce (Wells, 2000; Productivity Commission, 2005; Kamien & Cameron, 2006). Nowhere is this problem more acute than in non-metropolitan Australia, where many rural and remote communities suffer from inadequate access to appropriate and sustainable quality medical care (Humphreys & Dixon, 2004). Despite more than a decade of innovative rural workforce recruitment and retention policies and programs (Holub & Williams, 1996; Humphreys, et al., 2000; Lawson, et al.,

2000), the difficulty of attracting medical practitioners, particularly domestic medical graduates, to take up rural or remote practice continues for many regions.

A definitive explanation of why some communities face significantly greater difficulties in recruiting and retaining an adequate medical workforce than others is not clear. In general, two broad sets of factors influence decision-making in relation to recruitment and retention of country doctors - firstly, the professional needs and interests of the doctor, and secondly, a number of geographical, social, and community factors that impact upon personal satisfaction (Humphreys, et al., 2001). These latter external factors relating to environmental and place attributes can be subsumed under the concept of *rural amenity*. Despite widespread anecdotal evidence suggesting that some locations are perceived as not especially attractive places in which to work and live, little systematic research has been undertaken examining the link between the rural amenity and communities experiencing an undersupply of medical workforce.

This study investigates the extent to which there is a measurable association between medical workforce availability in non-metropolitan Australia and a selection of place characteristics descriptive of their isolation, climate, and overall rural amenity as viewed by doctors. *A posteriori* knowledge indicates that doctors do not perceive all rural locations as being equally attractive as places to live and work; however, little is known about which, if any, aspects of

rural amenity contribute to medical workforce shortage. This study will measure the strength of the relationship between rural amenity and medical workforce shortage, and which aspects of rural amenity are most significantly associated with workforce shortage. Such a study is warranted because of the need to ensure that policies designed to assist the recruitment to, and retention of, doctors in areas of medical workforce undersupply are effectively targeting those factors most influential in decisions about where to take up and/or remain in practice. Evidence-based workforce policy can only be grounded on a strong, rigorously derived knowledge base.

The paper comprises three main sections. First, the concept of rural amenity is reviewed, relevant data sources for its measurement examined and a brief validation of our selected indicators is provided. Second, definitions and measurement of medical workforce shortage are examined. Third, the relationship between rural amenity and medical workforce shortage is assessed, both in relation to the currently used District of Workforce Shortage (DWS) designation and alternative measures of medical workforce shortage. The paper concludes with a discussion of the key findings and their implications for policies relating to medical workforce provision in rural and remote Australia.

Section 1: Rural amenity

The concept of rural amenity (as viewed by doctors)

Rural amenity is a complex, somewhat elusive concept usually connoting some aspect of pleasantness or attractiveness. Commonly it has both a tangible

environmental component as well as a social and psychological dimension.

Environmental amenity, relating essentially to the external place attributes, has been shown to be a significant factor in both inter- and intra-regional migration and regional population growth in western countries (Graves, 1980; Mathur & Stein, 1991; McGranahan, 1999; Argent, et al., 2007; Rappaport, 2007). Not surprisingly, therefore, the demise, vulnerability or survival of many rural towns is often regarded as being dependent on the combination of two important factors, local employment opportunities and environmental amenity (Garnaut, et al., 2001; Stimson, et al., 2001; McGranahan & Beale, 2002; Green, et al., 2005).

Most studies have included some measure of climate as a key aspect of locational amenity. A 'pleasant' climate is a rather subjective notion depending on individual preferences. To most people it includes some combination of warmer weather, moderate humidity and rainfall, and a low number of rainy days across both summer and winter seasons (McGranahan, 1999; Deller, et al., 2001; Rehdanz & Maddison, 2005; Rappaport, 2007). Other climatic factors contributing to a place's amenity, but not used in this study, include the number of winter-sun hours per day, the number of extreme hot or cold days and average wind speed.

Other locational attributes considered important contributors to locational amenity include proximity to the coastline and other water bodies, low elevation, and proximity to snow. Terms such as 'sea-change' and 'tree-change' have

appeared over recent years to capture the attractiveness of areas which encompass these attributes (Burnley & Murphy, 2004; Salt, 2004). Economic indicators related to amenity include the levels of employment and infrastructure associated with recreational activities (Deller, et al., 2001; Kim, et al., 2005; Gunderson & Ng, 2006). Additionally, the economic literature suggests that population growth ought to be considered simultaneously with related indicators of economic growth, socio-economic status and housing price growth (Mathur & Stein, 1991; Deller, et al., 2001; Ferguson, et al., 2007; McGranahan, 2008; Wu & Gopinath, 2008).

Specifically for the medical workforce, rural amenity comes from not just physical environmental aspects, but also a number of other aspects of community locations that contribute to their work and life experience. For example, proximity to capital cities and large regional centres, proximity to hospitals and proximity to private schools are important attributes influencing their personal and professional locational decision-making (Humphreys, et al., 2001). In addition, demographic composition of a community including the numbers of elderly, unemployed or indigenous people may influence doctors' decision-making. For example, some doctors would view socio-economically deprived communities where 'bulk-billing' is expected to threaten practice viability. Overall rural amenity for the medical workforce reflects the combination of all contributing aspects.

Indicators used to measure rural amenity

In this study, twenty national variables collected from publicly available databases were selected to measure the rural amenity of a location. Note that an important consideration was to base this study on unambiguous indicators available in the public domain, both at the national level and for smaller geographical units. Climate data were sourced from the Bureau of Meteorology, elevation data from GeoScience Australia, house price data from the Australian Property Monitors, income data from the Australian Taxation Office, population size and demographics as well as geographic remoteness data from the Australian Bureau of Statistics, and proximity data was calculated as straight-line distance using ArcGIS 9.2 (ESRI, Redlands CA). The specific data items collected were:

1. Average January maximum temperature
2. Average July maximum temperature
3. Average annual rainfall
4. Average annual number of rain days
5. Average July humidity
6. Average January humidity
7. Proximity to the coast
8. Elevation
9. ASGC Remoteness Area scale (2006) (Australian Bureau of Statistics, 2003)
10. Socio Economic Index for Areas– Index of Relative Socio-economic Disadvantage (SEIFA-IRSD) (2006) (Australian Bureau of Statistics, 2006)

11. Median house price (2008)
12. Average taxable income (2007)
13. Population growth (1986-2006)
14. Town population size grouping (2006)
15. Proximity to nearest private school
16. Proximity to nearest public hospital
17. Proximity to nearest capital city
18. % Population aged 65+ (2006)
19. % Population indigenous (2006)
20. % Population unemployed (2006)

For our study, 2006 Census defined Urban Centres/Localities (UCLs) provided the common geographical unit for all data analysis. This scale was used to ensure the analysis captured important distinctions in rural amenity and because doctors' locational decisions assessing the desirability of a place to work relate more to specific practice locations than geographic regions. To omit large urban and regional centres, we limited UCLs to those with a population below 50,000. Additionally, UCLs with a population less than 500 ($n=608$) were excluded because such localities generally fall below the population threshold required to support a permanent resident doctor (Rural Doctors Association of Australia & Monash University School of Rural Health, 2003). Excluded small UCLs were similarly distributed against medical workforce shortage compared to included rural UCLs (see Table 2, $p=0.167$), thus their exclusion is unlikely to bias results. This left a total of 1116 rural UCLs across all of Australia.

Validation of the measurement of rural amenity

To test our choice of rural amenity indicators, two of the independent variables, housing price and population growth, were modelled as alternative outcome measures of overall rural amenity or 'attractiveness', as commonly reported in the economics literature (Mathur & Stein, 1991; Wu & Gopinath, 2008).

Multivariate backwards stepwise linear regression models were determined, using each of these outcomes at both national and state level. All models were estimated using SPSS 16.0 (SPSS, Chicago IL).

First, we used an area's population growth over 20 years as an alternative measure of place attractiveness. This was measured over four census periods (1986-1991, 1991-1996, 1996-2001, 2001-2006), with population change in each period categorised as 'Growth', 'Stable' or 'Loss', and the combined 20-year trajectory categorised as either 'strong growth', 'moderate growth', 'relatively stable', 'moderate loss', or 'strong loss'. As summarised in Table 1, rural population growth is moderately well explained by our set of amenity variables, with the proportion of variance captured (R-squared) varying between 37% and 60% across most states and 39% at the national level.

Secondly, we used a seven-category classification of a location's median house price (<\$150K, \$150-200K, \$200-250K, \$250-300K, \$300-400K, \$400-500K, >\$500K) as an alternative measure of place attractiveness. It is seen in Table 1 that the set of rural amenity variables explains housing price even better than

20-year population growth, with state-level models capturing between 65% and 81% of variance, and a slightly lower 64% at the national level. These results provide some validation of our selection of rural amenity variables in capturing a location's attractiveness.

[Insert Table 1]

Section 2: Medical workforce shortage

Measures of medical workforce shortage are used to indicate the existence of a deficit between the level of available medical services and the level required by the population. Population-to-provider ratios (PPRs), for defined geographic boundaries such as Statistical Local Areas (SLAs), are commonly used for this purpose (Luo & Wang, 2003; Primary Health Care Research & Information Service, 2010). The Australian Government Department of Health and Ageing (DoHA) calculates PPRs for all Australian SLAs, utilising Medicare Australia service billing data of general practice (GP) consultations and Australian Bureau of Statistics (ABS) population counts. District of Workforce Shortage (DWS) areas are then defined as those where the community has less access to medical services than the general population, by simply determining which SLAs have PPRs below the national average. Significantly, communities designated as a DWS are eligible for a wide range of recruitment and retention support measures and incentives (Australian Government Department of Health and Ageing, 2008, 2010).

Ten years of DWS data (reviewed every three months, giving 40 quarters, 1998-2008) were provided for this study by DoHA's Workforce Distribution Branch. DWS status for our last quarter (Sep 2008) across Australia is shown in Figure 1, whilst the most current DWS status is accessible online (Australian Government Department of Health and Ageing, 2010). The simplistic binary definition of DWS means that its designation can fluctuate regularly for a specific location. To smooth out some of this 'noise', we characterised areas according to their DWS status over each 2-year set of eight quarters; that is, as being 'mainly DWS' if in deficit for 5 or more quarters, or 'mostly not DWS'. Finally, a 10-year summary of DWS was calculated by aggregating the 2-year outcomes to produce an overall score on a scale of 0-5. To match the rural amenity location data, DWS designation which is determined by DoHA using SLAs, was attributed to the contained smaller localities (UCLs).

[Insert Figure 1]

DWS areas comprise predominantly, though not exclusively, small inland rural and remote communities, invariably located in less hospitable environments and some distance from major urban centres. However, with the rural medical workforce shortage remaining so acute and widespread over a long period of time, assessment against the national average means that most rural locations at any point in time have below average PPRs. It follows that the existing DWS measure is not very effective at differentiating workforce shortage between places. In fact, it is seen in Table 2 that DWS designation is a highly skewed variable with close to 60% of all rural UCLs remaining as DWS areas for most

quarters over the last 10 years. Thus, a linear (ordinary least squares) model is not appropriate to explain DWS designation and for this reason DWS was treated as an ordinal variable for the analysis reported in Section 3.

[Insert Table 2]

Because of the low discriminatory power identified for the DWS measure, two alternative measures of medical workforce shortage were added to the analysis. Firstly, we calculated our own population-provider ratios (PPRs) at the SLA level, using GP data extracted from the June 2008 AMPCo database (Australasian Medical Publishing Company, 2008). Note that the AMPCo database is a comprehensive and accurate listing of Australian doctors, available for licensing to researchers and other users which is updated daily via numerous sources including Medical Journal of Australia subscriptions, Australian Medical Association registrations and direct communication. Theoretically this dataset should constitute a better outcome measure for our model because it is a continuous measure without an arbitrary cut-off (national average), though it measures 'workforce shortage' at one point in time rather than across 10 years.

Secondly, we used McGrail's index of rural access (McGrail & Humphreys, 2009a, 2009c, 2009b) which was purposefully designed as an improved measure of access to GP services for rural populations. Once again, theoretically this index should provide a better outcome measure for modelling workforce shortage than either the AMPCo or DWS measures. Its additional

features, compared to previously described ‘simple’ PPRs, include the use of floating catchments rather than predefined boundaries (e.g. SLAs), the inclusion of distance-decay (i.e. reduced access due to decreasing proximity) and adjustments for a population’s relative health needs and mobility. Unfortunately, this index is currently only available for Victoria so our analysis was necessarily restricted to this state.

Section 3: Relationship between rural amenity and medical workforce shortage

The relationship between rural amenity and medical workforce shortage (DWS) was initially examined by calculating zero-order correlations, shown in Table 3, between DWS and the full list of rural amenity variables at both the national and state level. The most notable result is the consistently low correlation between DWS and each of the rural amenity variables. At the national level, all variables have a correlation less than 0.21 with DWS designation. In many cases the correlation increased slightly at the state level, but only a handful of rural amenity variables, mainly in Tasmania, have correlations with DWS designation greater than 0.30. Results for the Northern Territory have been omitted from Tables 3 and 4 due to small numbers of UCLs and more importantly their uniform DWS designation.

[Insert Table 3]

Ordinal multivariate regression models (Hosmer & Lemeshow, 2001) were then calculated with DWS designation as the dependent variable against rural

amenity variables. Table 4 summarises results at both the national and state levels. Final models were determined using backwards stepwise elimination, utilising a logit link function and $p=0.05$ was used as the threshold significance level for inclusion. It is apparent that all models using the 20 rural amenity variables are poor predictors of DWS designation. Pseudo R^2 (Cox and Snell) measures indicated that only in Western Australia (41%), South Australia (36%) and Tasmania (47%) were our models able to explain more than 25% of the variance in DWS designation, with the national level model only able to explain 13%. Interestingly, all state-level models outperformed the national model, but there does not appear to be any obvious pattern to the significant rural amenity variables for different states.

[Insert Table 4]

Next, we calculated linear multivariate models of continuous PPRs (using AMPCo data) against the same set of rural amenity variables. Whilst the explained variance did improve moderately for New South Wales and Queensland (to 42% and 31% respectively), in Western Australia and Tasmania they decreased (to 21% and 35% respectively), and were unchanged for Victoria and South Australia. Nationally, there was a small increase, but only from 13% to 18%.

Finally, we calculated a linear multivariate model of McGrail's index of access (Victoria only) against the same set of rural amenity variables. Interestingly, this resulted in a dramatic increase in the variance explained by rural amenity

variables, from around 20% (AMPCo) to 68%. This result exceeds all other workforce shortage model performances, which suggests that this index is likely to offer substantial improvements for other states when it becomes more generally available. Not surprisingly, correlations between the rural amenity variables and McGrail's index of access were significantly higher, with most being in the order of 0.30 to 0.60.

Discussion

This study is the first of its kind to measure the contribution of rural amenity to explaining patterns of medical workforce shortage in non-metropolitan areas. Unfortunately, our findings do not produce a definitive assessment of how important rural amenity is in explaining the pattern of medical workforce shortage. On the one hand, there appears to be a somewhat weak relationship between rural amenity and DoHA's designation of DWS. As noted earlier, this raises doubts about the adequacy of the DWS designation as a measure of an area's likely problems in recruiting and retaining doctors. In contrast, alternative outcome measures of medical workforce shortage showed a moderate-to-strong association with rural amenity and may therefore provide a better measure of the relationship in rural and regional Australia.

The extent to which these inconclusive results simply indicate a weak relationship between rural amenity and medical workforce shortage or rather are artefacts of the data or the study methods is not clear. Several limitations need to be acknowledged. Firstly, DoHA's definition of DWS as a two-state

variable, where nearly 60% of UCLs have maintained a medical workforce shortage status over 10 years, limits what can be achieved through statistical modelling. Secondly, DWS designation relates to broad areas (SLAs) compared with our use of discrete communities (UCLs), so some 'averaging out' within variables may occur. Thirdly, some of the independent variables used are characterised by low internal variation (for example ASGC Remoteness and climate), and this reduces their small-area discriminatory power. Fourthly, the scale of the study may itself have a confounding affect. Australia is a vast land covering almost 7.5 million square kilometres. While many large rural and remote areas may appear to be unattractive or inhospitable at the national level, attractive locations still exist within them. Our results indicate that state-level models are better predictors, highlighting the importance of the geographical scale of inquiry (Openshaw, 1984).

Studies such as this one inevitably are limited by the use of national secondary datasets, which determine what specific variables are available for analysis. Ideally, independent and dependent measures collected directly from the medical workforce would be preferred. However, unless conducted as part of the recently introduced national registration process for doctors, this remains highly problematic because it requires large resources and results in increasingly low response rates from over-surveyed doctors. To test our hypothesised relationship between rural amenity and medical workforce shortage, we adopted the most appropriate and best available outcome

measures and independent variables. Despite their shortcomings, particularly in regards to DWS designation, they are the best available data options.

A significant weakness with using the DWS measure is that a SLA can only be designated as either currently experiencing or not currently experiencing a shortage. No account is taken of whether an area *just* qualifies as a DWS, or is *well below* average. To reduce this limitation, we used historical DWS data over an extended period of time because areas of ongoing DWS designation are likely to have a PPR well below the national average. By definition, there will always be a significant number of locations designated as DWS by having their PPR below the national average, irrespective of whether the average truly represents a reasonable cut-off for defining workforce shortage. Given that it is impossible for all locations to be above average, it is questionable how effective this measure of workforce shortage can be in the long term as the basis for incentive schemes.

DWS designation attempts to identify areas (SLAs) currently experiencing sub-optimal workforce supply, but does not explain why areas of medical workforce shortage persist. Hence, for example, there is no attempt to distinguish between the professional factors that may deter the medical workforce (such as lack of procedural work, onerous on-call arrangements, difficulties in getting locum relief, inadequate workforce mix or poor infrastructure) and the environmental factors that may be highly significant, all else being equal in relation to professional factors. As such, this 'band-aid' approach of directing

incentives to identified workforce shortage areas without necessarily addressing underlying causal factors is unlikely to be effective in improving the long-term supply of doctors within rural Australia. Given the stronger correlation of rural amenity with a more appropriate and finer-grained approach to workforce shortage, such as McGrail's index of rural access to primary care, our results suggest that using such a measure may provide a better basis for targeting incentives.

The attractiveness of any rural location for medical practice is always influenced by both professional factors and the suite of geographical, social and community factors that we have considered here. In this study, we have sought to capture the non-professional factors through objective rural amenity variables. However, many other, often more subjective, community and social factors contribute to a location's attractiveness to an individual, such as isolation from family and/or friends, access to recreation interests, cultural isolation, access to shopping services, access to services providing for special needs, and employment opportunities for family members. It is difficult to quantify the influence of these since their relative importance is likely to vary greatly between individuals. Additionally, this study did not seek to capture any of the professional factors that are known to influence medical workforce location decisions, such as isolation from peers and other health services, level of remuneration, on-call commitments, access to continuing education, or ability to take leave from practice and to get 'time-out' from the community (Humphreys, et al., 2001; Wilson, et al., 2009). These issues require a high level of primary

data collection in order to discriminate their incidence between locations, and currently only limited national data exist.

This exploratory study is based on a conceptual framework which links objective characteristics of place with personal decisions about where to live and work (Humphreys *et al.*, 2001). We know that subjective perceptions of place intervene in this relationship. The work of environmental psychologists and behavioural geographers indicates that locations and regions considered to be characterised by high levels of rural amenity are likely to have associated positive images as prospective places to live and work (Gould & White, 1974; Gold, 1980). In reality, human behaviour including that of doctors is a manifestation of a complex array of intervening processes and filters which serve to modify decision-making and resultant behaviour (Gold, 1980). Our study did not explore such perceptions, and so the extent to which 'images' that medical graduates and other doctors have of different places are congruent with objective reality, remains poorly understood.

Conclusion

The current designation of rural regions experiencing medical workforce recruitment and retention difficulties as a 'District of Workforce Shortage' is of limited use for policy purposes without understanding the underlying factors that generate the problem. Given the increasing importance of evidence-based planning, a key goal of research in this area is to understand the key factors which differentiate locations in order to target workforce incentives and

interventions more effectively by ensuring that scarce resources are not wasted on measures or in areas unlikely to alleviate the problem. Currently, with the exception of International Medical Graduates, on whom many communities in these apparently 'unattractive' areas depend (Birrell & Hawthorne, 2004), there is little evidence that these incentives are successful in attracting medical practitioners (see for example (Buykx, et al., 2010)). While it is easier to target incentives at professional issues (such as supporting better continuing medical education or locum relief), evidence of the need to improve local amenity can assist the justification for programs which improve local community infrastructure (housing, schools, health facilities, transport etc) as well as funding regional development initiatives that can form the basis for improving local amenity over time.

Although our results show that rural amenity makes only a small contribution to explaining DWS designation, it is not clear whether this is due to the weak explanatory value of rural amenity, the inherent limitations of the DWS measure, or a combination of both. If the former is the case, professional factors might appear to be more fundamental in explaining DWS designation, though the extent of this would be difficult to quantify at present. However, our analysis using alternative measures of medical workforce shortage suggests that a significant association with rural amenity factors may exist. This study highlights the need for further research using comprehensive indicators that relate to the professional, geographical, economic and social aspects underpinning doctors' locational preferences and work-place decisions.

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Table 1: Summary of multivariate regression models of population growth and housing price

	NSW	Vic	Qld	SA	WA	Tas	NT	Aust
Population Growth								
(20 years) – R-squared	0.478	0.370	0.530	0.380	0.586	0.599	0.888	0.393
Significant variables (n)	8	9	9	7	9	5	10	11
Median House Price								
– R-squared	0.806	0.737	0.649	0.693	0.764	0.724	0.675	0.635
Significant variables (n)	13	13	8	7	8	7	3	12

**Table 2: Summary of DWS designation, 1998-2008, for all rural UCLs
(population 500 – 50,000) in Australia**

	Frequency	Cumulative (%)	Excluded UCLs <500 (Cum. %)
Consistently DWS - all (5/5) 2-year periods majority DWS	651	58.3%	62.8%
Mostly DWS (4/5)	92	66.6%	72.2%
Moderately DWS (3/5)	100	75.5%	79.9%
Sometimes DWS (2/5)	80	82.7%	85.0%
Mostly not DWS (1/5)	73	89.2%	91.8%
Consistently not DWS (0/5)	120	100.0%	100.0%
Total	1116		608

Table 3: Correlations between DWS designation and environmental amenity variables

	DWS designation (10 years)						
	NSW	Vic	Qld	SA	WA	Tas	Aust
Avg Jan Max temp	-0.018	-0.079	-0.063	0.101	-0.261	-0.380	-0.121
Avg Jul Max temp	0.227	-0.041	-0.141	0.076	-0.244	-0.101	-0.103
Avg Annual Rainfall	0.317	0.069	-0.029	-0.172	0.087	0.500	0.022
Avg Annual Rain days	0.297	0.062	0.005	-0.076	0.259	0.392	0.148
Avg Jan Humidity	0.248	0.067	-0.060	-0.057	0.145	0.521	0.030
Avg Jul Humidity	-0.120	0.106	0.029	-0.191	0.307	0.153	0.144
Proximity - Coast	0.213	0.026	0.001	0.124	0.076	0.212	0.097
Elevation	-0.081	0.035	-0.037	-0.055	-0.104	0.029	-0.064
ASGC Remoteness	-0.104	0.218	-0.039	0.129	-0.077	0.237	-0.029
SEIFA- IRSD	-0.071	0.025	0.104	0.291	0.058	0.214	0.041
Med House Price	0.214	-0.025	-0.003	-0.128	-0.036	-0.234	-0.009
Avg Taxable Income	0.054	-0.057	-0.174	-0.134	-0.258	0.146	-0.136
Popu Growth (20 yr)	0.034	-0.077	0.024	-0.034	0.068	-0.319	-0.015
Town Popu Size	0.058	0.234	0.145	0.283	0.235	0.150	0.152
Proximity - Priv School	0.098	-0.040	0.001	-0.046	-0.096	-0.247	0.016
Proximity - Pub Hosp	0.069	-0.009	0.141	0.172	0.207	0.254	0.123
Proximity – Cap City	0.044	-0.204	0.082	0.046	0.084	-0.450	0.047
% Popu aged 65+	-0.036	0.184	0.270	0.405	0.263	0.006	0.210
% Popu unemployed	0.038	-0.051	0.086	0.127	-0.007	0.213	-0.004

% Popu indigenous	-0.069	0.044	-0.094	0.130	-0.106	0.109	-0.126
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Table 4: Summary of multivariate ordinal regression models of DWS designation (national and state level)

<i>Ordinal regression significant variables</i>	NSW	Vic	Qld	SA	WA	Tas	Aust
Avg Jan Max Temp	X				X	X	X
Avg Jul Max Temp							X
Avg Annual Rainfall		X		X	X		
Avg Annual Rain Days	X		X				X
Avg Jan Humidity	X						
Avg Jul Humidity			X	X	X		
Proximity - Coast					X	X	X
Elevation	X		X			X	
ASGC Remoteness		X		X	X	X	X
SEIFA - IRSD							
Med House Price	X		X		X		
Avg Taxable Income			X				X
Popu Growth (20 yr)	X						
Town Popu Size		X	X	X	X		X
Proximity - Priv School						X	
Proximity - Pub Hosp	X		X		X		X
Proximity – Capital City				X		X	
Population % Indigenous							X
Population % Aged 65+		X	X	X			X
Population % Unemployed		X					X

DWS designation (10yr) -

pseudo	0.217	0.225	0.177	0.363	0.410	0.473	0.129
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R-squared (Cox/Snell)

Additionally, principal components analysis of rural amenity indicators identified four components with eigenvalues over one and captured about 67% of the variance. However, when these components were used in place of the 20 indicators, all DWS designation models captured significantly less of the outcome variance.

Figure 1: District of Workforce Shortage designation, September 2008.

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