Investigating the Coherence of Regions in Australia's Economic Geography

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Abstract: This paper analyses data at an official Australian spatial regionalisation based on administrative boundaries and compares it to an alternative aggregation of Australia's statistical geography based on commuting data. The alternative aggregation is defined as a functional region that is better equipped to capture the mechanisms of the existing labour markets and provide better information to policymakers. Several tests are employed to investigate the coherence of the small areas that make up these functional regions. It is found that the functional aggregation based on commuting data shows greater coherence for labour participation data, but not for income data.

1. Introduction

It is well known that Australia's regions experience varying rates of unemployment at any point in time (Mitchell and Carlson, 2005). Having access to accurate data is an important first step for researchers and policymakers in addressing these differences. The delimitation of regions at which data is disseminated is of paramount importance in realising the usefulness of the data. A region must exhibit functional similarities so policies targeted to regions can be effective.

The possible problem of data that is improperly disseminated is a consequence of what Openshaw (1984:3) calls the Modifiable Areal Unit Problem (MAUP). This has long been recognised by geographers, but has only recently been getting exposure in the economic literature. MAUP points out that the aggregation of areas is "arbitrary, modifiable and subject to the whims and fancies of whoever is doing, or did, the aggregating." This is a possible problem in the Australian context as most intercensal economic statistical data is provided by the Australian Bureau of Statistics (ABS) based on surveys they carry out. Due to their limited resources the ABS has defined regions by which they disseminate their data that are not necessarily based on labour markets; they follow a greater adherence to administrative areas. Two possible problems can arise from this. The first is measurement error, where a small area can be aggregated in a larger area that it has very little in common with. The second is that the large areas' statistics may suffer from spatial spillovers, for example, where a small area has more connection with its neighbouring large area, than the large area it is aggregated with. Spatial spillovers result in spatial autocorrelation, which affect the statistical analysis of data (see Cliff and Ord (1973), Anselin (1988) and LeSage and Pace (2009) for a full discussion).

One of the most important notions in the discussion of labour utilisation and underutilisation is the identification of a probable labour market, an area where jobs and employees, and job vacancies and prospective employees come together. A labour market can be identified as an area within which a large amount of self-contained commuting occurs. These labour markets have many names throughout the literature; we will refer to them as functional regions. It is logical to assume that data that is not classified in regions that have functional similarities will provide little insight into addressing the needs of regions. OECD member countries identified that "the main advantage (of functional regions) ... is to help identify those areas with specific problems, and therefore in need of assistance" (OECD, 2002:14).

The most common way to define a functional region is to use one of a variety of techniques that employ commuting flow data. Brown and Holmes (1971), Masser and Brown (1975) and Coombes *et al* (1986) have provided three such techniques to define functional regions using commuting flows. Each method has been used subsequently over the years by researchers to define their own functional regions, for example Cörvers *et al* (2009), Nel *et al* (2008) and Watts (2004) respectively.

In this paper we look at a delineation of Australia based on the Intramax method (Masser and Brown, 1975) and compare this to the ABS delimitation. We will do this using variance tools and regression analysis of four main economic indicators. Our aim is to measure the relative coherence of the smaller areas that make up the regions and thus determine which aggregation's regions are a more functional delimitation.

The paper is set out as follows. Section 2 outlines the Intramax method which will be used to design the functional region delimitation. Section 3 describes the two different sets of regions that will be compared. Section 4 presents the methods and results for the concentration and variance measures. Section 5 outlines our primary testing method. Section 6 gives the results of these and some discussion, and concluding remarks follow.

2. The Intramax Method

The method we will use to combine smaller areas into larger regions for the functional delimitation is known as the Intramax method. It is a hierarchical aggregation procedure that combines areas based on interaction data. In our case the interaction data are the commuting flows between Statistical Local Areas (SLAs).

We can consider the commuting flows from SLA to SLA to be represented as an n x n matrix similar to the one below.

	Region 1	**Region 2**	**...**	**Region j**	**Total**
Region 1	a_{11}	a_{12}	...	a_{1j}	$\sum_j a_{1j}$
Region 2	a_{21}	a_{22}	...	a_{2j}	$\sum_j a_{2j}$
...	...	...	...	...	...
Region i	a_{i1}	a_{i2}	...	a_{ij}	$\sum_j a_{ij}$
Total	$\sum_i a_{i1}$	$\sum_i a_{i2}$	...	$\sum_i a_{ij}$	$\sum_i \sum_j a_{ij} = n$

In the matrix above, the first row indicates all the commuting flows that start in region 1 and end in regions 1, 2, ..., j. The last cell in the first row is the total number of commutes that start in region 1. In this case region 1 is the origin zone. The first column on the other hand indicates all the commuting flows that end in region 1, having started from regions 1, 2, ..., i. The bottom cell in the first column is the total number of commutes that end in region 1. In this case region 1 is the destination zone. The top left hand cell of the matrix is the intrazonal flow for region 1, that is commutes that start and end in region 1. This is termed an intrazonal flow. The diagonal cells of the matrix show the intrazonal flows for all regions.

The matrix above gives the "observed" flows for each corresponding origin and destination zone. The Intramax method compares the observed flows with "expected" flows, which is simply the flow amount that would be expected in each cell given the total amount of flows and the total number of zones. For a particular cell (x,y) this can be represented by:

$$a^{*}_{xy} = \frac{\sum_i a_{iy} \sum_j a_{xj}}{n}$$

Masser and Brown (1975:512) explain the difference between the observed and the expected flows "is a measure of the extent to which the observed flow exceeds (or falls below) the flow that would have been expected simply on the basis of the size of the row and column marginal totals."

The objective function of the Intramax method then is the "maximum difference between the observed and the expected values of the flows, in both directions, between any pair *i* and *j*":

$$X = (a_{ij} - a^{*}_{ij}) + (a_{ji} - a^{*}_{ji}), \qquad i \neq j$$

The Intramax method combines regions together in a hierarchical, stepwise procedure where at each step two regions are clustered together that then become a new region. The particular regions that are fused are those that maximise the objective function above. At each step of the Intramax method, when two separate regions fuse together, the total intrazonal flows increase. This would continue until eventually all regions have fused together, to create just the single region with 100% of flows at this point intrazonal.

To make the Intramax method useable some appropriate stop point must be chosen at which the clustering procedure would discontinue and the resulting regionalisation would be defined. There are two main approaches to deciding how and when to stop the clustering. The first is by the amount of total interaction that at each step becomes intrazonal. In this case the user may have a pre-determined amount or percentage of interaction they want to stop the clustering at, or alternatively they may want to see where there is a large increase in the intrazonal flows. Alternatively, the user may want to stop the Intramax method when a pre-determined number of regions has been formed. This latter approach is how we will stop the clustering for the functional regionalisation in this paper.

Masser and Brown (1975) place a contiguity constraint on their Intramax method, to ensure that regions that fuse together are contiguous. We have not used such a constraint in running our Intramax method, however at no point do regions fuse which are not contiguous.

3. The Regionalisations

For the purpose of this paper, we only include the regionalisations for the states of New South Wales, Victoria, Queensland and South Australia and the territory of the Australian Capital Territory (collectively known as East Coast plus South Australia). These 5 states/territories (hereafter all to be referred to as states) are interconnected in a commuting sense, meaning there are cross border commuting flows from each state into at least one other state. Further, there is no one area or conglomeration of areas that are separated from the rest in terms of their commuting flows.

3.1 ABS Labour Force Regions

Up until the 2011 Census of Population and Housing (hereafter Census), following each Census the ABS produced a set of regions which they termed their Labour Force Survey dissemination regions (hereafter Labour Force Regions or LFRs). These were generally based on one or more of their other statistical levels outlined in the Australian Standard Geographical Classification (ASGC) (ABS, 2006).

The design of the LFRs is “based on standard geographical regions and are mostly identical in terms of spatial definitions with the Statistical Regions of Statistical Geography” (ABS, 2009). There is no mention of the LFRs adhering to any semblance of local labour markets. LFRs comprise a mixture of Statistical Regions, Statistical Region Sectors and Statistical Divisions. Some LFRs are a combination of one or more of the above regional classifications.

Following the 2006 Census the ABS outlined 68 separate LFRs (ABS, 2009) across Australia, 56 of these lay in the East Coast plus South Australia area that we are concerned with. All LFRs are an aggregation of smaller areas known as Statistical Local Areas (SLAs). SLAs are the primary spatial level at which the ABS provides its data. In all there are 1122 SLAs in the East Coast plus South Australia region.

The ABS follows certain protocols in producing its LFRs, to fit in with both sampling restrictions and its self-imposed classification requirements. The first is that as the LFRs provide the dissemination areas for surveys, they need to be large enough in population to give a sufficient sample size. If LFRs were too small the standard errors for their statistics would be too large to give any level of certainty. Secondly, LFRs must fit nicely into capital city and state boundaries. Hence, a LFR cannot cross a state border and they are designed to fit into the ABS defined capital cities.

It is worth mentioning that the 2011 Census saw the ABS introduce a completely new geographical classification, called the Australian Statistical Geography Standard (ASGS) (ABS, 2010a). This new classification includes a specific spatial level that will disseminate data gathered from the Labour Force Survey, called Statistical Area 4s (SA4s). These are aggregations of smaller areas called SA2s and in describing their design the ABS (2010b:4) stated that “labour markets will be a key consideration in the design of SA4s.” In their design, many of the restrictions that were placed on the LFRs have remained. As no data is yet available for this classification it cannot be included in this analysis.

3.2 Functional Region Delimitation

We use the Intramax procedure to aggregate our Functional Regions (FRs). As shown in the previous section the Intramax procedure is a hierarchical aggregation method which combines areas that maximise the objective function based on their commuting flows. For this purpose, we use commuting flows at the SLA level for the East Coast plus South Australia area.

The commuting data we used were the Journey to Work flows from the 2006 Census. Before we started the Intramax procedure, we needed to “clean” the commuting data to make it workable. Firstly, we eliminated SLAs that had no usual resident or working population and hence no commuting flows. Secondly, as the Intramax procedure requires an area to have both incoming and outgoing flows, we eliminated SLAs with only intrazonal flows or with only one direction flows. Finally, we eliminated flows that were over 300km in length (taking SLAs’ population weighted centroids as the reference points), as we assume that these are not regular commutes but a result of the way the commuting question was asked in the Census. So our commuting flows dataset consisted of the commuting flows from the remaining 1106 SLAs on which we ran the Intramax procedure.

As discussed in the previous section, the Intramax procedure combines areas which increases the total intrazonal interaction at each step. The procedure eventually combines all areas, so that 100% of the flows are intrazonal. One can stop the procedure either at a preferred percentage of total intrazonal interaction, or at a preferred number of regions. In our case, we wanted the number of regions to be the same as the LFRs, 56. Hence we stopped the Intramax procedure when it had created 56 regions, at which point total intrazonal interaction was 89.7%. Thus, for these 56 regions, 89.7% of the total number of commutes in our dataset are intrazonal. Individual regions may contain more or less than this proportion of the commutes for the SLAs it contains.

We didn't place the same boundary restrictions on the FRs as the ABS does on its LFRs. Hence, we have seven regions that cross state borders and others that cross the ABS capital city borders. Also, we placed no minimum population requirements on the FRs, so there are some quite small regions and conversely, some very large regions. The nature of the Intramax procedure is to combine areas in large volume commuting areas proportionally quicker than areas with low volumes. Hence, we only have three FRs for the entire Sydney region, compared to the ABS LFRs which comprise thirteen. In contrast there are only eight LFRs for the balance of NSW, while these same areas make up part of or an entire twenty FRs. This makes sense from a labour market perspective as people are more likely to commute to work halfway across a densely populated city, than halfway across a sparsely populated state.

4. Preliminary Analysis

One simple way of comparing the different regionalisations is to examine the statistical dispersion of areas within a region. Essentially, if an aggregation of small areas to regions is based on labour market movements, then it should follow that the small areas within a particular region should be more homogeneous or functionally similar. As a preliminary step, we will use some standard measures of concentration and dispersion to test whether this is the case.

We will use four economic indicators as our test statistics: employment as a proportion of the working age population (aged 15+) (Emp/WAP), the unemployment rate (UR), the proportion of part-time employment to total employment (PT/Emp) and average income (Inc). We will take the data from the 2006 Census. Census data for income level gives the number of people in a particular income range, so the medians of the ranges were used. As both the LFRs and the FRs are aggregations of SLAs, our analysis will look at the concentration and variance of the SLAs within regions for both delimitations.

Our first measure is the Theil Index, which is a standard measure of concentration. For the employment as a proportion of working age population statistic, the level of concentration between SLAs within a region, the Theil Index is defined as:

$$T \equiv \sum_{i=1}^{n} \left(\frac{e_i}{e_r}\right) \ln\left(\frac{x_i}{\bar{x}}\right)$$

where e_i is the level of employment in SLA i, e_r is the level of employment in the total region, x_i is the employment to working age population ratio for SLA i, and $\bar{x}$ is the average employment to working age population ratio for the region. The Theil Index for the other indicators follow the same formula. A Theil Index of zero would indicate all SLAs have the mean rate and there is no inequality between them. As the Theil Index increases away from zero, the more unequal are the comprising SLAs.

Table 1 gives some statistics of the distribution of the Theil Indexes across the regions for both regionalisations. As can be seen in the table the Emp/WAP statistic shows that the FRs have greater concentration in their SLAs for all measures of distribution. For the UR and the Inc statistics, the FRs have a greater mean, but have lower 1st, 2nd and 3rd quartile values, indicating that most of the FRs are more concentrated than their LFR counterparts, but there are some higher values that skew the mean. The FRs' SLAs exhibit greater dispersion for the PT/Emp statistic.

Table 1 Theil Index distribution statistics for Regions

	Simple Mean		**1st quartile**		**Median**		**3rd quartile**	
	FR	LFR	FR	LFR	FR	LFR	FR	LFR
Emp/WAP	0.0043	0.0049	0.0019	0.0022	0.0033	0.0036	0.0053	0.0071
UR	0.0395	0.0386	0.0159	0.0214	0.0269	0.0380	0.0535	0.0538
PT/Emp	0.0087	0.0043	0.0017	0.0012	0.0029	0.0022	0.0057	0.0053
Inc	0.0102	0.0093	0.0012	0.0045	0.0042	0.0084	0.0084	0.0134

Source: ABS Census 2006, author's calculations

The Coefficient of Variation is a measure of relative dispersion. It is defined as:

$$CV = \frac{\sigma}{\bar{x}}$$

where σ is the standard deviation of the SLAs' statistics within an FR or LFR and $\bar{x}$ is the mean. For our purposes we used a weighted mean for the entire region. A value of zero would indicate complete equality of the SLAs within the region. The further the value is away from zero, the greater the dispersion of SLA values.

Table 2 shows the distribution statistics of the Coefficient of Variation for the different regionalisations. Again the Emp/WAP statistic exhibits less dispersion in the FR delimitation than the LFR delimitation. In this case the Inc statistic also exhibits less dispersion in the FRs' SLAs. The UR shows the same as the Emp/WAP and Inc statistics except for the 3rd quartile statistic. While, as with the Theil Index, the PT/Emp statistic shows greater dispersion among a region's SLAs for the FR delimitation.

Table 2 Coefficient of Variation distribution statistics for Regions

	Simple Mean		**1st quartile**		**Median**		**3rd quartile**	
	FR	LFR	FR	LFR	FR	LFR	FR	LFR
Emp/WAP	0.1188	0.1210	0.0759	0.0782	0.1111	0.1130	0.1407	0.1490
UR	0.3736	0.3770	0.2374	0.2439	0.3199	0.3200	0.4113	0.3875
PT/Emp	0.1447	0.1284	0.0774	0.0551	0.0988	0.0896	0.1984	0.1480
Inc	0.1432	0.1621	0.0777	0.1168	0.1212	0.1518	0.1833	0.1987

Source: ABS Census 2006, author's calculations

In summary, we can conclude that these tests show that the statistics for employment as a proportion of working age population in SLAs of a region exhibit greater concentration and less variance in the functional region delimitation than they do for the LFRs. Similarly, while not all distribution statistics are in accordance, a clear majority shows that overall the statistics for the unemployment rate and average income exhibit the same. In contrast, the statistics for part-time employment as a proportion of total employment exhibit greater concentration and less variance in the LFRs as opposed to the FRs.

5. Testing for the Coherence of Regions

We follow Cörvers *et al* (2009) in the methodology we will use to test for the coherence of the SLAs within each of the regions for both regionalisations. It follows that the larger the coherence of SLAs within the same regions (the ABS regions or the functional regions), the larger the differences in economic and labour market performance between the SLAs of different regions.

Cörvers *et al* begin by setting out a commuting model of labour markets. The model shows how the ability of people to commute across regions reduces wage inequality. The hypothesis then is that regions that are delineated using commuting flows will have a more equal income distribution. Cörvers *et al* compare the administrative regions in the Netherlands to a functional region delineation they design using the Mean First Passage Time method (Brown and Holmes, 1971). They use four economic indicators to test the coherence of their regional delimitations; income being the first, flowing on from their commuting model, as well as housing costs, employment and unemployment. They state that "since higher wages will raise housing prices and will pull more individuals to the labour market, higher costs of commuting might also be reflected in larger interregional differences in housing prices and labour participation (i.e. employment rates)" (2009:25).

Due to a lack of available data, we are unable to test for the coherence of housing costs, but instead use the same economic indicators and data we used in Section 3: employment as a proportion of the working age population (aged 15+) (hereafter employment rate), the unemployment rate, part-time employment as a proportion of total employment (hereafter part-time employment rate) and average income. Hence we have three indicators of labour participation and one of income.

The test involves running ordinary least-squares regressions for each of the indicators for both regionalisations. The regression uses the average value for each SLA as the dependent variable, with the explanatory variables being dummy variables for each region. Hence for the employment rate indicator, each SLA's employment rate is regressed on dummy variables representing each of the 56 FRs or LFRs. This can be represented as follows:

$$Emp_S = \beta_0 + \sum_{k=1}^{n-1} \beta_k * delimitation$$

where Emp_s represents the employment rate for the SLAs, β_0 is the average employment rate of the SLAs in the reference region, n is the number of regions in the delimitation and β_k is the difference between the average employment rates of the reference region's SLAs and region k's SLAs. Another way of representing this is for the functional region delimitation:

$$Emp_S = \beta_0 + \beta_1 * FR_1 + \beta_2 * FR_2 + \beta_3 * FR_3 + \ldots + \beta_{55} * FR_{55}$$

The regressions are repeated for all combinations of regions, taking a different reference region each time. This procedure is performed for each of the four economic indicators for each regionalisation.

The dummy variables are used to account for the differences in each of the indicators between regions. We want to test whether there are any significant differences between the different groups of SLAs that make up the different regions with regard to each of the indicators. Essentially, the more significant differences that exist between the regions in the estimated regression equations, the lower the interaction of workers between the regions and in turn the more functional the regions are for the purpose of analysis.

6. Results and Discussion

The SLA averages for each of the economic indicators were regressed on the dummy variables for each of the regions for both delimitations. Our regressions will give us the number of regions that contain SLAs with significantly different statistics to the SLAs in other regions for each of the four economic indicators. The delimitation that contains SLAs of greater coherence will be the one that has the greater number of significant differences between regions for each of the economic indicators.

As mentioned in Section 2, for the East Coast plus South Australia area that we are looking at the LFR delimitation has 1122 SLAs, while the FR delimitation has 1106 SLAs. In both cases these are distributed across 56 regions. As we have 56 regions, each region's SLAs are compared to the SLAs in the other 55 regions. So in all we have 1540 combinations of two regions (or region couples).

The regression results show that, in general, the positive and negative signs of the regression coefficients are in line with what would be expected. A region with a greater average employment rate of its SLAs will have a smaller average SLA unemployment rate and greater average SLA income. The correlation of the part-time employment rate to the employment rate and unemployment rate varies a little. This can be explained by the change in the prevalence of part-time employment in more recent years and the people who now participate in part-time employment. It has traditionally been assumed that people in part-time employment are more precarious in their employment and are therefore more susceptible to losing employment, especially in tougher times. However, with the trending increase in part-time employment in recent years (Mitchell & Muysken, 2008), in some instances a large proportion of part-time employment has been taken by previously unemployed persons leading to a rise in employment overall. A similar result was found in Mitchell and Bill (2004:20) where part-time employment as a proportion of total employment influenced the unemployment rate in a negative way.

Of course the regression analysis wasn't needed to identify the positive and negative signs or magnitude of the differences in one region's average SLA statistics compared to another region's for each of the indicators we are looking at. We could have simply averaged the SLAs' statistics for a region and compared them to other regions. However, what the regression analysis does tell us is the number of these differences that are statistically significant. Table 3 gives a list of the number of significantly different region couples for each of the indicators for both delimitations. It also gives these as a percentage of the total 1540 region couples that exist for the 56 regions. We consider a difference to be significant at the 5% level.

Table 3 Number and percentage of significant differences

	FR		**LFR**	
	No.	%	No.	%
Emp/WAP	512	33.2	317	20.6
UR	366	23.8	80	5.2
PT/Emp	569	36.9	296	19.2
Total Labour Part.	1447	31.3	693	15.0
Inc	415	26.9	705	45.8
TOTAL	1862	30.2	1398	22.7

Source: ABS Census 2006, author's calculations

As can be seen from the table, for the functional region delimitation the three labour participation indicators all have significantly more differences between one region's SLAs compared to another region's SLAs than do regions in the LFR delimitation. Collectively, this means that 31.3% of FR couples have significant differences across the three labour participation indicators, compared to just 15.0% of LFRs. In contrast, the income indicator has significantly more differences between regions for the LFR delimitation than for the FR delimitation. It also has the greatest number of differences in total.

The fact that the differences in the average income level between a region's SLAs was more significant for the LFR delimitation, while the three labour participation indicators showed more significant differences for the FR delimitation, was a curious result that demanded further investigation. A closer inspection proved that there were a large number of these differences between LFRs for the income indicator between capital city region couples. We mentioned previously that the LFR delimitation divides the capital city regions up into many more regions than the functional delimitation. This means the LFRs are much smaller in the capital cities than the FRs. Hence, there is substantial commuting between LFRs in the capital cities. The commuting model put forward by Cörvers *et al* (2009) would suggest that because there is still a large amount of cross border commuting between the capital city LFRs then the SLAs within these individual LFRs would be similar to the SLAs within other LFRs in the same city. This is the case with the three labour participation indicators, but is the opposite with the income indicator.

Table 4 shows the extent of this inequality across the four capital cities for the LFR delimitation (the ACT is treated as one LFR, so is not included here). For Sydney LFRs, the significant differences in region couples for the three labour participation indicators total 11 from a possible 234 (4.7%). However, the differences in the average income statistics total 45 out of 78 (57.7%). The other cities show similar results.

Table 4 Difference in the significant differences between capital city LFRs

	Sydney (13 LFRs)		**Melb. (9 LFRs)**		**Brisbane (5 LFRs)**		**Adelaide (4 LFRs)**	
	No.	%	No.	%	No.	%	No.	%
Total Labour Part.	11	4.7	3	2.8	3	10	0	0
Income	45	57.7	19	52.8	6	60	3	50

Source: ABS Census 2006, author's calculations

Hence this result goes totally against the commuting model of Cörvers *et al* (2009) in relation to income. The cross commuting that occurs between LFRs has not decreased the inequality in income levels over these areas. On the other hand, the results for the labour participation indicators follow the commuting model nicely. The conclusion one might draw from this is that while workers can commute across a large part of a capital city for work, income levels remain clustered in pockets throughout the city.

In summary then, it is reasonable to conclude that the functional delimitation does produce more coherent regions than does the ABS LFR delimitation for labour participation indicators. That is, commuting between SLAs decreases the inequality in labour participation across those SLAs and this is reflected in the way a functional aggregation of SLAs shows greater significant differences in SLAs of different FRs than in the administrative aggregation. Alternatively, it can also be concluded that the functional delimitation does not produce more coherent regions than the ABS LFR delimitation when it comes to income levels and that the LFRs are actually a better classification for representing income data.

7. Conclusion

This paper has attempted to compare the performance of different delimitations of the regions in the East Coast plus South Australia area of Australia. The comparison has been made between an official, administrative delimitation, designed by the ABS to fit certain guidelines and restrictions, and a functional delimitation designed using an algorithm that groups small areas based on their commuting data. The functional regions are therefore characterised by having largely self-contained labour markets, within which a high percentage of total commuting interaction occurs, leaving limited spatial spillovers.

Both sets of regions have the same number of regions to allow for comparison. We tested our regions using the data for four economic indicators: employment as a proportion of the working age population, the unemployment rate, part-time employment as a proportion of total employment and average income. The first three of these measure aspects of labour participation, while the fourth is an income measure.

Our initial testing methods employed concentration and variance tools and overall the functional delimitation provided better results. For three of the four indicators, the distribution of the concentration and variance measures heavily favoured the functional delimitation as being the better grouping. The alternative indicator was the part-time employment rate, where regions in the administrative delimitation proved to contain more concentrated SLAs with less dispersion.

Our more formal testing method tested the significance of the difference between the SLAs in one region compared to the SLAs in other regions for the same delimitation. The greater the number of significant differences in the SLAs between region couples, the greater coherence the regions demonstrate. The method provides a way a testing which regions contain small areas (in our case SLAs) that are more functionally similar and at the same time more functionally dissimilar to the small areas in other regions.

The tests uncovered distinctly different trends that exist across the labour participation indicators as opposed to the income indicator. The three labour participation indicators all showed that significantly more of the SLAs in regions in the functional delimitation are significantly different to the SLAs in other regions for the same delimitation, than they did for the administrative delimitation. Hence the regions in the functional delimitation would be said to exhibit greater coherence than in the administrative delimitation.

In stark contrast to this the income indicator showed that significantly more of the region couples in the administrative delimitation than the functional delimitation had significant differences in their SLA income levels. A closer inspection found that the theory of the commuting model of a labour market (Cörvers *et al*, 2009), that the ability of people to commute between areas will lower the inequality of income between regions, does not hold in this case. In particular, the four state capital cities displayed that they all have great income inequality between their regions, despite the amount of commuting that happens between the regions.

In conclusion we can say that for labour participation the functional region delimitation does provide more coherent regions and would be a superior classification to the ABS administrative delimitation. However, for measuring income, the inequalities that exist in the capital city regions lead to the administrative delimitation being the more coherent of the two.

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