REGIONAL SUICIDE DISPARITIES IN QUEENSLAND: TEMPORAL MEASUREMENT AND INTERPRETATION

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ABSTRACT: By applying the relevant economic techniques for studying regional disparities to regional data on suicide in Queensland, this study establishes an important temporal aspect of suicide that does not belong to the domain of epidemiology. Equations are modelled on several dispersion measures. The sign on the slope coefficient determines whether regional disparities in Queensland have lessened or increased through time. At a time when concern about social and economic fragmentation exists, it is vital to inform regional policy by results that apply the relevant quantification technique. Interpretations appropriate to this literature are discussed.

KEY WORDS: suicide, regional disparities, measuring dispersion, economic inequality

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R10, I14, A13

1. INTRODUCTION

We demonstrate that suicide data at the regional level are amenable to the empirical techniques of descriptive analysis of disparities. These data have not yet been analysed with the appropriate analytical tools. The empirical approach addresses important technical issues in the literature on measuring inequality regionally, in particular the Welfare Economics basis of inequality measurement. This study is in the genre of three Australian studies which are descriptive analyses of disparities. These studies are concerned with regional labour market variables (Dixon *et al.*, 2001; Dixon, 2006; Dixon and Mahmood, 2006), following Martin's (1997) application of absolute dispersion and relative dispersion measures to regional unemployment data for the United Kingdom.

This topic is well placed in a literature concerned with regional economic and societal forces; it would be misplaced in other literatures, such as epidemiology, psychology, psychiatry, mental health services research, suicide prevention research etc. This is not just due to the technical emphases herein; the Discussion section emphasises that a study of suicide can belong with the economic, social and regional disciplines that are concerned with population-level issues. The effectiveness of health/welfare services can be constrained by economic factors underlying spatial inequalities in access. The interpretation of the disparities reported here is also informed by a phenomenon in suicide, described as psychache by Shneidman (1993). These points are all considered in the Discussion section where we discuss, in a preliminary way, the basis by which the phenomenon of psychache may also be subject to regional disparities.

Studies of regional disparities in the 'standard' variables, e.g. regional labour market disparities, regional income disparities etc, hardly summon any need for justification. A relatively early example of the former is Martin (1997) and, of the latter, Borooah *et al*., (1991). This is not the case with studies of regional disparities in suicide. Often-personal reactions occupy minds well before the empirical basis of evidence-based policy can be examined; also some readers may place considerable focus on suicide data being less-than-ideal, a problem that is now well-documented. All reactions to suicide, and philosophical stances about suicide, can be debated in another forum. For the present, several policy-relevant statements will be made.

First, there is a fully developed Welfare Economics argument available now, indicating that suicide prevention is a legitimate objective of government policy (Doessel and Williams, 2010). Whilst there is also increasing knowledge of the prevention strategies internationally that can avert some suicide deaths (Mann *et al*., 2005), Williams and Doessel (2007a) provide some evidence that the stock of knowledge that can decrease the trend in suicide mortality is extremely limited relative to other causes of mortality. Second, the suicide rate in Australia has a rising secular trend (Doessel *et al.*, 2010a; Doessel *et al.*, 2010b), a trend that can be viewed as 'an outcome' of poorly understood social, economic and intra-individual forces. Third, suicide is not a trivial cause of death: in 2002 the World Health Organization (WHO) attributed approximately 1.5 per cent of the global burden of disease to suicide (WHO, 2003). Moreover, it is not just the rising mortality trends due to suicide, but the increase in the amount of lifetime foregone over the twentieth century due to suicide, measured by the Potential Years of Life Lost measure (Doessel *et al.*, 2009), that is of concern. Fourth, since Émile Durkheim's *Le Suicide*, suicide has been regarded as not just a personal act but also as a phenomenon that is **a societal outcome**. Cameron (2005) places emphasis on Durkheim's conception in an economic framework. Durkheim identified four types of suicide and Cameron (2005, p. 232) argues that Durkheim placed or 'located' the four types of suicide 'within a grid of social regulation' (Cameron, 2005, p. 232). From this perspective, the central reason that any type arises, as Cameron states, is that the individual 'is unable to integrate his or her needs adequately with those of society' (Cameron, 2005, p. 232). Finally, the fact is also simply that national suicide prevention strategies **are** in place, whether efficacious or not, in many Western countries. Such are the dynamics that motivate this descriptive study in which we emphasise empirically whether, or not, 'the world', when conceived of in terms of the set of factors producing suicide rates, 'is flat' (with apologies to Friedman's *The World is Flat*...), and whether, by implication, the forces producing the spatial pattern are temporally constant.

Several studies (that, broadly speaking, are of an 'epidemiological' kind) are available that report on some Australian suicide rates by various regional classifications. There are more than twenty studies that date from the early 1970s to the present. They are discussed in our working paper (Williams *et al*., 2012). See also the studies in Kölves *et al.* (2012), which is a government report. Many of the studies cited find that suicide rates are higher in regional and rural areas than in urban areas, and because most studies report this result, a consensus or generalisation has formed from this literature. However, further study is warranted. Williams *et al.*

(2012) discuss detail that needs to be examined concerning such a generalisation.

It cannot be emphasised enough that there is **little uniformity** across all studies and their results. The various studies differ in terms of regional classifications employed, measures invoked, procedures applied etc. It must be noted also that there is no uniformity in location of the studies: some are based on Victorian data, some on Queensland data or those of New South Wales etc. The studies also examine varying time periods.

This literature also indicates a significant lacuna. The gap concerns the trend in regional suicide disparities through time. We suggest that the generalisations which have formed about heightened rates of rural suicide may be too hasty. The results of Qi and co-authors (Qi *et al*., 2010; 2012) suggest also that there is much detail in data at a lower level of geographic analysis that is yet to be fully examined. As yet, no study has reported on the temporal trend in the regional variation of suicide rates. In quantifying the temporal trend in disparities, this study applies several measures of dispersion to the regional data on suicide rates. Details are reported elsewhere (Williams *et al.* (2012). There is a very good reason for applying several measures of dispersion. A study of regional distributions, dispersion or inequality ought never to derive its conclusion from a single measure, or just a few measures; an explanation of this exhortation is in Williams and Doessel (2006) in the context of mental health services. The appropriate approach to the second research question is to calculate and report various measures of inequality, in a manner akin to sensitivity analysis.

Following this introduction, section 2 outlines key aspects of the empirical method. Section3 presents our central empirical results. Section 4 is concerned with discussion of our results. Our conclusions are presented in the 5th, and final, Section.

2. METHOD

This study answers two questions about the spatial distribution of suicide rates using time-series data for Queensland. Initially we ask, 'Are suicide rates higher in rural areas in comparison to urban areas?' This question addresses a longstanding issue, for which there are conflicting answers. Our main focus is on a second research question: are suicide rates by geographical region converging through time or is there a diverging trend in Queensland? In other words, are regional disparities lessening, or increasing, through time? The test for convergence/divergence here is based on temporal movements towards/away from the weighted mean for all the regions.

The Data on Suicide

The selection of the study area, *viz.* the State of Queensland at the level of regions, relates to the quality of available Australian data. The Queensland Suicide Register (QSR), which is managed by the Australian Institute for Suicide Research and Prevention (AISRAP), is a comprehensive database of suicide mortality containing information on all suicide deaths for Queensland residents since 1990. The Australian Bureau of Statistics (ABS) also collects suicide data but those data have been subject to various enumeration problems (See Williams *et al.* (2012) for details.)

The study period encompasses 18 years from 1990 (the first year of QSR data) to 2007. Between 1990 and 2007, there were 9 393 cases of suicide recorded in the QSR. Of those, 230 cases (or 2.5%) were excluded due to the deceased permanently residing in a country other than Australia (n=15), a State other than Queensland (n=67), having an unknown or no fixed place of abode (n=143) or being in long-term institutionalised care at the time of death (n=5). The final database includes 9 163 persons (7 245 males, or 79.1% of all suicides (as enumerated), and 1 918 females, or 20.9% of all suicides.

Each suicide case was located within a Statistical Local Area (SLA) based on the residential address, following the 2001 edition of the Australian Standard Geographical Classification (ASGC). Following the ASGC, every QSR case was assigned to one of **seven** regions, each of which defined by one or more Statistical Division (SD). These regions are **Brisbane City** (Brisbane City); **Outer Brisbane** (Gold Coast City A, Beaudesert Shire Part A, Caboolture Shire Part A, Ipswich City (Part in BSD), Logan City, Pine Rivers Shire, Redcliffe City, Redland Shire); **Coastal Part A and B** (Gold Coast City Part B, Sunshine Coast); **Darling Downs and Wide Bay** (Moreton SD Bal, Bundaberg, Hervey Bay City Part A, Wide Bay-Burnett SD Bal, Toowoomba, Darling Downs SD Bal); **Mackay-Fitzroy** (Rockhampton, Gladstone, Fitzroy SD Bal, Mackay City Part A, Mackay SD Bal); **Western** (South West, Central West, North West); **North and Far North** (Townsville City Part A, Thuringowa City Part A, Northern SD Bal, Cairns City Part A, Far North SD Bal).

Suicide mortality rates for each of the regions were calculated per 100 000 population for males and females, as well as Queensland as a whole. These rates are based on the number of identified deaths (from the QSR) for the population residing in those regions at time of death and the annual estimated resident population data, as at 30 June for the years between 1991 and 2007. These population data were obtained from the Queensland Regional Statistical Information System (QRSIS). QRSIS is a regional database maintained by the Office of Economic and Statistical Research, using the data collections of the ABS. Regional population data for males and females for the year 1990 were calculated by assuming the proportional increase in the population figures between 1990 and 1991 as observed in period 1991-1992. Table 1 presents the suicide rates for the seven regions of Queensland averaged over the 18 years of annual rates and also the weighted average for all regions.

Table 1. The Average Suicide Rate for Seven Queensland Regions on 18 Years of Annual Rates and for Queensland (Weighted for all Regions), 1990-2007.

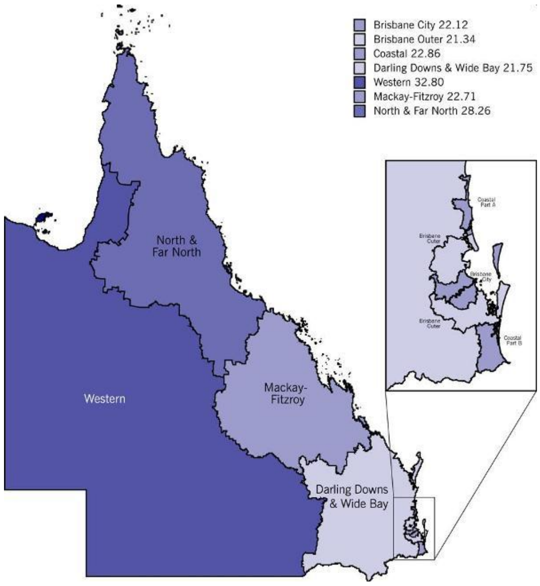
	Brisbane City	Outer Brisbane	Coastal	Darling Downs	Mackay-Fitzroy	Western	North and Far North	Qld
Males	22.12	21.34	22.86	21.75	22.71	32.80	28.26	23.64
Female	6.61	5.67	7.35	4.79	5.26	6.24	6.55	6.19

Source: Calculated from Queensland Suicide Register data.

Note that the mortality rates reported here are not age-standardised. Annual age data at the regional level which will enable accurate age-standardisation are not available and, in view of the nature of this exercise and the fact that the relatively short study period hardly requires age-standardisation, unadjusted data are employed.

The regional pattern can also be depicted visually by the application of some techniques of chloropleth mapping. See the maps in Figures 1(a) and 1(b). These maps indicate the spatial variation for male and female suicide mortality for the seven regions of Queensland, for the whole period 1990 to 2007. It should be noted that applying chloropleth mapping makes a (visual) assumption that intra-regional rates across each region are uniform.

(a) Males



(b) Females

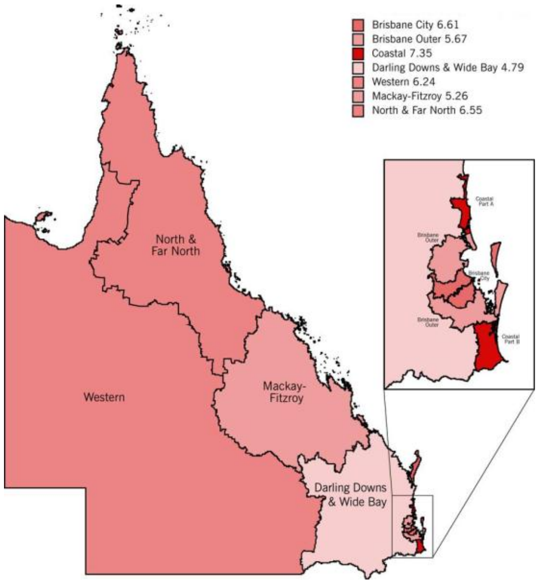


Figure 1. The Suicide Rates Aggregated 1990-2007, Mapped for Seven Regions of Queensland. Source: Calculated from Queensland Suicide Register data.

Some Descriptive Statistics

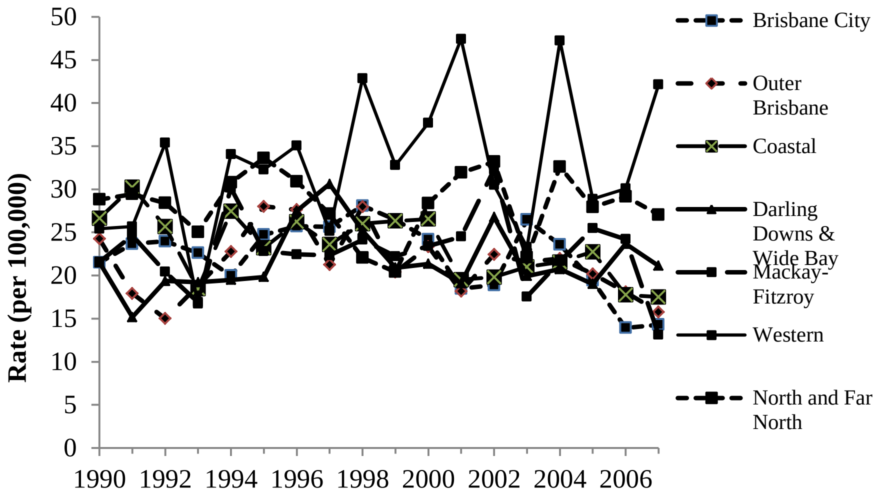
Figure 2 (a) and (b) present the time-series plots of Queensland's regional suicide rates for males and females on the raw data for the seven Queensland regions, and the State of Queensland.

Several comments are relevant about the plots in Figure 2(a). First a 'mixed picture' for males is apparent. Some regions are characterised by marked 'swings' from one year to another (due to low numbers in those regions); there is some suggestion of a rising trend in other regions; and in yet other regions a falling trend appears likely. Second, the graph for the Western region is markedly different from the plots for all the other regions. Third, most regions have some quite low rates per 100 000 males, such as Mackay (16.89, 1993; 13.12, 2007), Brisbane City 13.93, 2006; 14.30, 2007), Darling Downs (15.17 1991); Coastal (17.52, 2007); Outer Brisbane (14.99, 1992), Western (16.72, 1993). The highest rates for males occurred in the Western region (47.43, 2001; 47.22, 2004). Fourth, in some regions, the male rates are variable. It may be thought that this is due, in part, to low population. However, in other regions, the plots indicate low rates that are relatively smooth (e.g. the Darling Downs and Coastal). Relatively even, but high, rates through time are found in the North and Far North region.

The 'picture' in Figure 2(b) for females is as visually chaotic as it is for males; however the graphs reveal a very different pattern for females from those for males. First, the numeration on the *y*-axis for females indicates the markedly lower rate of female suicide relative to male suicide. Second, it is noteworthy that, due to the lower numbers, the female data seem generally subject to even greater 'oscillation' than are the male data. Third, a 'mixed picture' for females, like that described above for the male data, is also apparent. Fourth, the regions for which there are lower rates per 100 000 males are not the same regions as those for females' and the regions where the highest rates have occurred do not appear to be the same as for males.

Clearly, further examination of these data is required. Given the focus of the research question, attention will turn now to determining the relevant approach to measuring the regional pattern of dispersion and inequality in suicides rates for the seven regions of Queensland.

(a) Males



(b) Females

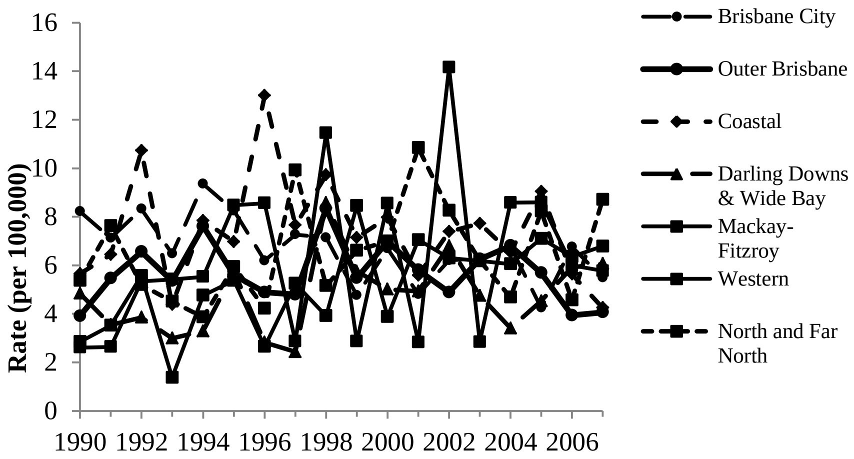


Figure 2. Suicide mortality rates per 100,000 males and females for seven Queensland regions, 1990-2007. Source: Calculated from Queensland Suicide Register data.

Regional Dispersion and Inequality Measures

Various measures of inequality and dispersion are available and can be applied to these data in order to generate the data sets for statistically analysing the disparities. In matters of policy about economic welfare, it is vital to recognise the measures that link a social welfare function to the assumptions underlying the measure being applied. For details, see *inter alia* Cowell (1995), Barr (1998), Johnson (1996), Creedy (1998).

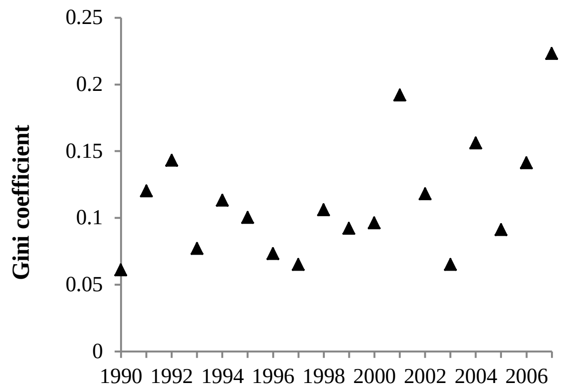
Inequality measures tend to be applied most frequently to income data. Le Grand (1987; 1989), Illsley and Le Grand (1987) and Silber (1982; 1983; 1988) were the first scholars to apply inequality measures to health phenomena. The basic notion is that conceiving of the distribution of well-being, in its broadest definition, incorporates the length of lifetime, or the loss of life. Two recent studies (Williams and Doessel, 2009a; 2009b) have applied inequality measurement to mental health status. These studies of suicide are based on the age distribution of the length of the life foregone. However these studies have a different focus from the emphasis here. We are concerned here with measuring **spatial inequality** in suicide rates *per se*. However, the point still stands that the social welfare function is relevant to all exercises in quantifying inequality.

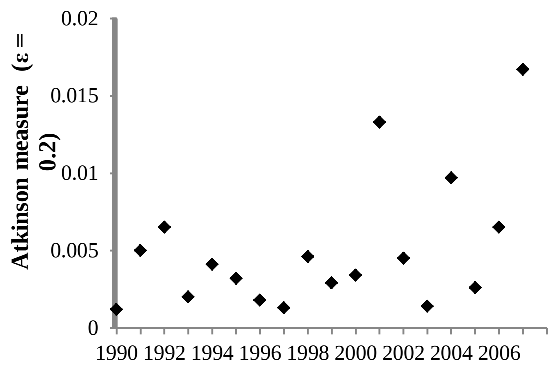
With respect to determining whether the spatial inequality in suicide rates is increasing or decreasing through time, it is well known that applying various measures to the same data set may yield different answers. The pragmatic advice to the empirical researcher is not to base a conclusion on a single measure of inequality: the most appropriate procedure is to calculate, and report, a number of different measures of inequality. The different measures may well lead to the same conclusion which can be thought of as ‘a nice result’(Such a case can occur.) For example, the present authors have studied changing geographical dispersion of psychiatric services in Australia, using four different measures of equality (Williams and Doessel, 2009b). If ‘a nice result’ does not occur, then all results are still reported and the differences outlined in accordance with what the various measures quantify. Such a research strategy is like a sensitivity analysis.

We applied six measures of dispersion, in all, to the suicide rate data: the standard deviation (SD), the coefficient of variation (COV), the Gini coefficient (GINI) and the Atkinson Measure of inequality ($A_{0.2}$ and $A_{1.4}$). In addition to these measures, two other specific measures of distribution in the regional studies literature are applied. They are generally lesser known, although they are employed in literatures such as labour economics. The first is the absolute measure of dispersion (AD_{SR}), which is explained (in the context of unemployment) as follows: "[absolute dispersion] measures the number of persons in all regions taken together who would have to change their labour market status in order for every region to have the same percentage unemployed as currently prevails for the [population] as a whole…" (Dixon, 2006, p. 208). Following Martin (1997), an alternative measure, the relative dispersion of the suicide rate (RD_{SR}), can also be defined. Further details of all these measures are provided in our working paper (Williams *et al.*, 2012).

Figures 3 and 4 present time-series plots of three of the six measures of dispersion and inequality applied to the male and female suicide rates, respectively. It is not necessary to report the plots for the other measures; the interested reader can find all the figures in Williams *et al.* (2012). Note these Figures include also just one of the two Atkinson measures applied (the $A_{0.2}$) in order to save space and because, on these data, both the $A_{0.2}$ and the $A_{1.4}$ plots are similar.

Visual inspection of these Figures indicates that there are similarities and differences across the various measures for both the male data sets and the female data sets. Also, it is apparent in Figure 3 that the dispersion and inequality measures produced more fluctuating measurements post-2000; however it is not possible to investigate the pattern further in this study.





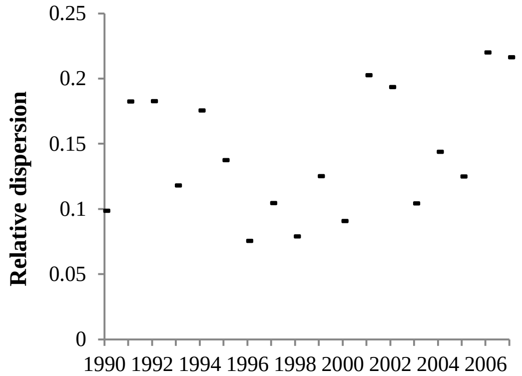


Figure 3. Three Dispersion and Inequality Measurements on Male Suicide Rates for the Seven Regions of Queensland, 1990-2007. Source: Calculated from Queensland Suicide Register data.

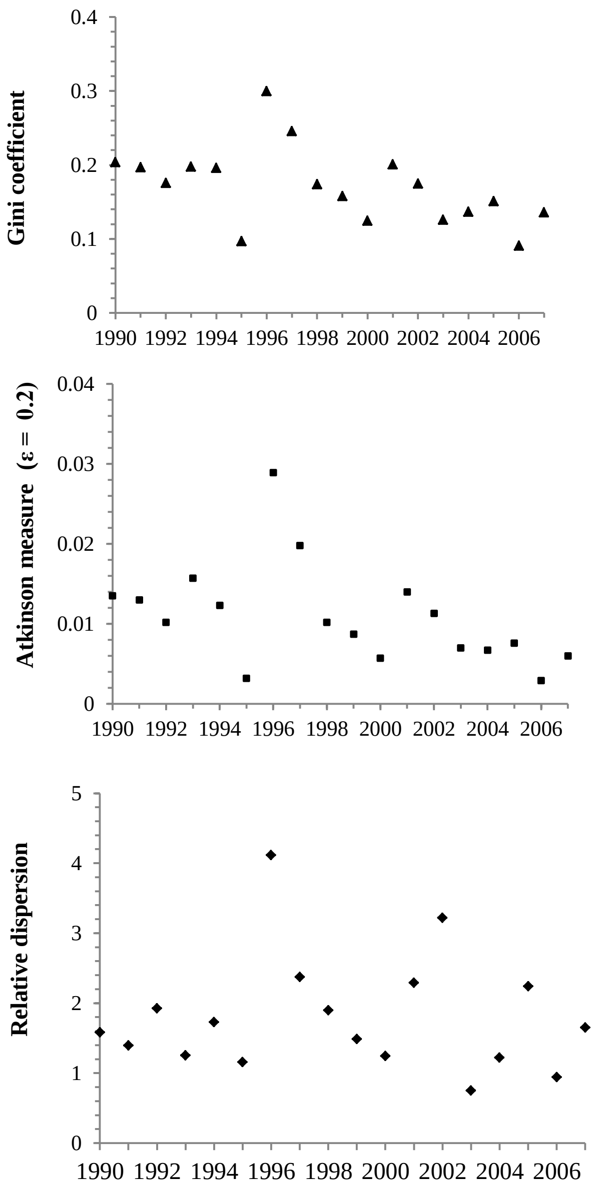


Figure 4. Three Dispersion and Inequality Measurements on Female Suicide Rates for the Seven Regions of Queensland, 1990-2007. Source: Calculated form QSR data

Dispersion Analysis

The next step in our analysis is to determine the sign on the slope coefficient for the estimated equations, thus providing an answer to our second research question as stated in our Introduction. The positive, zero or negative sign on the time coefficient (if statistically significant) determines whether the regional dispersion or inequality in suicide rates in Queensland is respectively increasing, constant or decreasing for each measure over the study period. Because male and female suicide behaviour is very different, the total is not analysed as space is not available for reporting on the total rates.

Equations were modelled on the distributional data generated by applying the six measures discussed above: SD, COV, GINI, $A_{0.2}$ and $A_{1.4}$, AD_{SR} and RD_{SR}. The inequality data (so obtained) suggest that linear and quadratic forms are the likely models to fit these data, i.e. Equations [3] and [4], respectively:

$$D^{SR(M)}_{Reg\,(i)} = \alpha_1 + \alpha_2 t + \alpha_k \boldsymbol{X}_k + \mu_t \qquad [3]$$

$$D^{SR(M)}_{Reg\,(i)} = \alpha_1 + \alpha_2 t + \alpha_3 t^2 + \alpha_k \boldsymbol{X}_k + \varepsilon_t \qquad [4]$$

where $D^{SR(M)}_{Reg\,(i)}$ is the regional distribution (so measured)(i.e. by SD, COV, AD, RD, Gini, $A_{0.2}$, $A_{1.4}$) on male suicide rates in Region *i*; *t* is time; $\boldsymbol{X}_k$ is a vector of pulse dummy variables that may affect $D^{SR(M)}_{Reg\,(i)}$; $i = 1, ..., 7$ i.e. the ‘Big 7’ regions of Queensland; μ is ‘white noise’, ε is ‘white noise’; and α_1, α_2, α_3, α_k are the parameters to be estimated. Since the impact of institutional and environmental variables is not known, the error term captures those effects. The same steps were then undertaken on the female inequality data sets.

3. EMPIRICAL RESULTS

Given that goodness-of-fit results are necessary, but not sufficient, indicators of the confidence that can be placed in estimated equations, thorough diagnostic testing was undertaken. Five diagnostic tests (for serial correlation, normality of the residuals, heteroscedasticity, correct specification of functional form, and stationarity of the residual) were applied.

Diagnostic testing was undertaken initially on linear time trends, and ordinary least squares (OLS) estimation was found to provide a poor fit. The initial modelling also generated somewhat ‘nonsensical’ results. It became apparent, given the data were very 'bumpy' (due to small numbers), that it was appropriate to calculate three-yearly moving averages. This step smoothed the yearly observations. Further diagnostic testing found serial correlation in the RD data sets for females (It was also in the AD data sets for males and females, but those equations are not reported here). The insertion of a first order autoregressive error term *AR(1)* in these three equations addressed that problem. The implementation of pulse dummy variables addressed the effect of outliers. The Ramsey RESET test indicated that polynomial equations, estimated under non-linear least squares, would improve the performance of all the male equations, and also some of the female equations.

A set of equations for which the sign on the coefficient can be confidently reported has been obtained. These results are presented in Table 2 for males and Table 3 for females for three of the six inequality measures. The full tables reporting the results of all six measures are in Williams *et al.* (2012).

Table 2. Estimated Time Trends on Three Measures of Dispersion of Suicide Rates (Three-yearly Moving Averages), Queensland, Males, 1990-2007.

	Gini Coefficient	*Relative Dispersion*	*Atkinson Measure*	
			ε = 0.2	*ε = 1.4*
Intercept	0.10*** (15.65)	1.06*** (18.32)	0.00*** (13.90)	0.02*** (15.05)
Time	-0.01*** (-4.73)	-0.08*** (-4.34)	-0.00*** (-3.95)	-0.00*** (-4.51)
Time^2	0.00*** (6.18)	0.01*** (8.03)	0.00*** (5.26)	0.00*** (5.76)
DV1998_2000	-	0.57*** (8.09)	-	-
DV1999_2000	0.04*** (5.37)	-	0.003*** (8.75)	0.02*** (8.72)
DV2002_2003	0.04*** (5.37)	-0.33*** (-4.54)	0.003*** (8.75)	0.02*** (8.72)
Goodness-of-Fit				
$\bar{R}^2$	0.84	0.95	0.84	0.87
F	27.47***	74.29***	27.20***	27.33***
Diagnostic Tests				
Breusch-Godfrey (*F*)	0.13 (p=0.72)	0.31 (p=0.59)	0.02 (p=0.89)	0.00 (p=0.98)
Breusch-Pagan Godfrey (*F*)	2.25 (p=0.14)	1.68 (p=0.22)	1.70 (p=0.22)	1.75 (p=0.21)
Ramsey RESET (*F*)	0.15 (p=0.71)	0.94 (p=0.46)	6.85 (p=0.02)	3.28 (p=0.07)
Jarque-Bera (χ^2)	0.32 (p=0.85)	0.95 (p=0.62)	0.06 (p=0.97)	0.02 (p=0.99)
AD-F (*t*)	I(0)**	I(0)**	I(0)*	I(0)*

Notes: ε The inequality aversion parameter of the Atkinson measure which takes two assumed values (0.2 and 1.4) in this exercise. [a]Data in parentheses below the equation coefficients are *t* statistics; *p* values are reported for the diagnostic test results. [b] $\bar{R}^2$ is the coefficient of determination, adjusted for degrees of freedom. [c] *F* is a test of the joint hypothesis that all coefficients equal zero. [d] Breusch-Godfrey is an LM test for serial correlation. [e] Breusch-Pagan-Godfrey is a test, based in the *F*-distribution, of the hypothesis that heteroscedasticity is absent from the residuals. [f] Ramsey RESET is an *F*-test of the hypothesis that the specification of the equation is correct. [g] Jarque-Bera is a χ^2 test for normality of the residuals. [h] AD-F is the Augmented Dickey-Fuller test for stationarity of the residuals, and I(0) indicates that the residuals are stationary. [i] One, two and three asterisks indicate statistical significance at the ten, five and one per cent levels respectively.
Source: Calculated from Queensland Suicide Register data.

Table 3. Estimated Time Trends on Three Measures of Dispersion of Suicide Rates (Three-yearly Moving Averages), Queensland, Females, 1990-2007.

	Gini Coefficient	***Relative Dispersion***	***Atkinson Measure***	
			ε = 0.2	*ε = 1.4*
Intercept	0.16^{***}	0.26^{***}	0.01^{***}	0.06^{***}
	(35.21)	(12.19)	(31.04)	(21.74)
Time	-0.01^{***}	-0.01^{***}	-0.00^{***}	-0.01^{***}
	(-13.12)	(-3.46)	(-6.94)	(-5.94)
Time^2	-	-	0.00^{***}	0.00^{***}
			(2.70)	(2.51)
DV1994_96	0.03	-	0.00	0.02
	(5.27)		(5.11)	(5.00)
DV1996_97	-	0.20^{***}	-	-
		(6.15)		
DV1997_99	-0.04	-	-0.00	-0.02
	(-8.04)		(-4.84)	(-4.50)
DV2001	-	-	-	-
DV2005	-	0.15^{***}	-	-
		(2.26)		
AR(1)	-	-0.54^{**}	-	-
		(-2.02)		
Goodness-of-Fit				
$\bar{R}^2$	0.96	0.70	0.97	0.96
F	119.04^{***}	9.26^{***}	111.61^{***}	91.00^{***}
Diagnostic Tests				
Breusch-Godfrey (*F*)	0.03	3.17	0.13	0.21
	(p=0.87)	(p=0.11)	(p=0.72)	(p=0.65)
Breusch-Pagan Godfrey (*F*)	0.22	1.12	0.55	0.49
	(p=0.88)	(p=0.38)	(p=0.70)	(p=0.74)
Ramsey RESET (*F*)	2.62	1.55	2.49	2.68
	(p=0.12)	(p=0.27)	(p=0.13)	(p=0.12)
Jarque-Bera (χ^2)	1.04	1.88	0.64	0.66
	(p=0.60)	(p=0.39)	(p=0.73)	(p=0.72)
AD-F (*t*)	$I(0)^{**}$	$I(0)^{**}$	$I(0)^{***}$	$I(0)^{***}$

Notes: ε The inequality aversion parameter of the Atkinson measure which takes two assumed values (0.2 and 1.4) in this exercise. [a]Data in parentheses below the equation coefficients are *t* statistics; *p* values are reported for the diagnostic test results. [b] $\bar{R}^2$ is the coefficient of determination, adjusted for degrees of freedom. [c] *F* is a test of the joint hypothesis that all coefficients equal zero. [d] Breusch-Godfrey is an LM test for serial correlation. [e] Breusch-Pagan-Godfrey is a test, based in the *F*-distribution, of the hypothesis that heteroscedasticity is absent from the residuals. [f] Ramsey RESET is an *F*-test of the hypothesis that the specification of the equation is correct. [g] Jarque-Bera is a χ^2 test for normality of the residuals. [h] AD-F is the Augmented Dickey-Fuller test for stationarity of the residuals, and I(0) indicates that the residuals are stationary. [i] One, two and three asterisks indicate statistical significance at the ten, five and one per cent levels respectively.
Source: Calculated from Queensland Suicide Register data.

Male Suicide

Table 2 indicates a negative and statistically significant coefficient on Time in each of the equations for males. The negative sign confirms a declining trend from higher to lower values on these inequality measures. Thus there is a **converging regional trend** on the measures of inequality applied to the male suicide data. Although the coefficient on Time^2 in each equation is low in value in several equations, it is statistically significant in all male equations. Thus, it is not spurious to state that on the basis of the existing study period, the likelihood exists that a turning point towards divergence, not rejected on present data, occurred at the end of the study period.

Female Suicide

The results in Table 3 for female suicide also indicate negative and statistically significant coefficients on Time on these equations. The negative sign on all measures confirms a declining trend and thus a regional trend for female suicide that **converges through time**. Note that there is little variation in the slope across the inequality measures. The value of the coefficient on Time^2 is very low in three equations and, although statistically significant, there is very little evidence across all measures to suggest that there has been a turning point towards regional divergence in female suicide.

These results on dispersion clearly present some new information on suicide rates. The reader ought to note that our purpose is achieved in demonstrating appropriate empirical technique: we show that suicide data at the regional level are amenable to the empirical techniques of descriptive analysis of disparities. Suicide data have not as yet been analysed with the relevant tools of analysis for regional disparities. Important technical issues discussed in the literature on measuring regional inequality, particularly the Welfare Economics basis of inequality measurement, are relevant to suicide data not only to data on the 'usual' disparity topics, such as income inequality and unemployment.

4. DISCUSSION

Explanatory factors for the disparities are not analysed in this study. Some studies are available on some of these factors, e.g. Milner *et al.*

(2012) for Queensland, in addition to Qi *et al.* (2009; 2010; 2012); Middleton *et al.*, (2008); and Saunderson and Langford, (1996). There is also a recent, comprehensive, overseas study of risk factors available internationally (Gunnell *et al.*, 2012); this is an exercise in spatial epidemiology. Gunnell and co-researchers report changes in the spatial epidemiology of male suicide in England and Wales that are not explained by 'the usual' risk factors through time.

A point for discussion concerns services, preventive services in particular. The present study emphasises *inter alia* that, despite the fact that effective prevention can ameliorate regional disparities in suicide rates, service efficacy is often subject to spatial forces. This problem is seldom studied. In the period of intense risk for the suicidal individual, there is a dangerous period of time until the ultimate act of suicide. The duration of this time period can be thought of as about equivalent to the period of ultimate danger for life-threatening conditions like myocardial infarction, stroke, road trauma, snake bite etc. The risk of mortality when the threat to life is suicide may well be greater (and thus mortality is heightened) if services are inefficaciously supplied or inadequately financed. This point is noted from time to time in the Australian media (See Cook (2012), for example.) Some empirical results are available on the regional inequality of access to mental health services under Australia's Medicare financing (Williams and Doessel, 2007b; Williams and Doessel, 2009b). These studies suggest that, in two decades of Medicare subsidies, there has been little change in the regional inequality in the provision of private psychiatric services in Australia: regional inequality in the production of such services seems relatively intractable.

Another rationale for measuring or quantifying regional suicide disparities relates to equity. Typically, the forces that bring longevity to the population of a nation, or a region, are not experienced evenly across that population. 'Untimely' mortality occurs in most acts of suicide. Regional disparities in suicide are but another aspect of an uneven experience of longevity. The presence of inequity relates to the tendency for suicide to involve untimely loss of life. Further discussion is available in Williams *et al.* (2012).

Finally, it is relevant to place this analysis of suicide in a wider perspective. It was pointed out above that suicide in Australia is subject to a rising secular trend. It may be useful to conceive of this secular trend, and the regional pattern as described here, as 'outcomes' of poorly understood social, economic and intra-individual forces. One of Shneidman's contributions (1993) is a statement of 'psychache', the 'cause' of suicide. Shneidman came to this perspective after decades of clinical experience with people at risk of suicide (and survivors of suicide attempts). In addition the detail of the notion of psychache is informed by neurobiological aspects of suicide (Mann (2005) provides a relatively non-technical account of this technical literature). It is also important to note that 'psychache' is not synonymous with 'depression', or any other mental health disorder. Mental illness, substance abuse, job loss or relationship breakdown, aggressive or impulsive personality traits, a sense of despair, access to methods of suicide (guns, medications, rope, knives etc.) and so forth are to be understood as precipitating factors (or pre-conditions) to the ultimate act of suicide, the immediate cause of which is psychache. Such factors (as mentioned above), *inter alia*, are the forces that intensify the psychache that leads to the deadly act.

Is psychache but a part of a more general phenomenon? Space is not available here to discuss these points or the availability of some answers to the question; an elaboration is available in Williams *et al.* (2012). However, the argument can be put briefly here that a general concept, emotional violence, is a factor in the development of psychache. By implication one could consider whether regional and temporal variation in emotional violence can occur, and/or people's ability to endure it. For example, Cameron (2009) provides an economic discussion of hostility. It is an empirical matter as to whether 'emotional violence' and psychache are markers of the modern era: are there increasing secular trends in these variables? Are there regional disparities? Answering these questions *a posteriori* is unlikely on available data; and yet various disparate literatures can enable the conceptualisation of some answers and some *a priori* evidence.

Accumulating knowledge about suicide is a relatively neglected exercise, and subject to much misplaced belief. A conceptual and empirical economic argument about this point is in Williams and Doessel (2007a) and in that context we note Joel Mokyr's opening sentence in his *The Enlightened Economy*... which emphasises the place of knowledge: 'economic change in all periods depends, more than most economists think, on what people believe' (Mokyr, 2010). Mokyr's argument is as relevant to conventional economic issues, like economic growth, as it is to other issues, such as regional suicide disparities, and the patterns in psychache and emotional violence. Clearly, several disparate literatures can inform this argument: the relevant disciplines are not just those that have conventionally studied suicide.

5. CONCLUSION

This empirical study answers two questions: ‘are suicide rates higher in rural areas in comparison to urban areas?’ and ‘are suicide rates by geographical region converging through time or is there a diverging trend?’ The answers to both questions are reported here for male and female suicide data, and are not aggregated, as the suicide rates for males and females are so very different. Male suicide is highest in remote areas whilst female suicide is highest in coastal regions and inner metropolitan areas.

The second question elaborates on the answer to the first question by determining the temporal trend towards the weighted mean across all regions. Statistically significant results are reported on three measures of dispersion and/or equality. A converging regional trend is found on all measures applied to the male suicide data. This trend is qualified with an hypothesis that a turning point towards divergence occurred, which is not rejected on present data, at the very end of the study period. A converging regional trend is found also for female suicide rates. There is very little evidence in the female data also, across all measures, to suggest a turning point occurred towards a diverging temporal trend across the regions.

Importantly, this study shows as well the appropriate technique for answering the second research question, which has often been overlooked. Furthermore, the study demonstrates very markedly that ‘the world’, when conceived of in terms of the set of factors producing suicide rates, ‘is not flat’, and that the forces producing the spatial pattern of suicide rates are not temporally constant.

Attention has been given in the Introduction, and in the Discussion, to matters about interpreting results about suicide and regional disparities of appropriate interpretation of suicide (and its regional disparities) for literatures other than epidemiology and health services research. A further clear conclusion of this study is that there is still more work to be done.

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