

# **A Geographically Weighted Regression Analysis of General Election Turnout in the Republic of Ireland**

**Adrian Kavanagh<sup>1</sup>**  
**Richard Sinnott<sup>2</sup>**  
**Stewart Fotheringham<sup>3</sup>**  
**Martin Charlton<sup>4</sup>**

**Paper presented to the  
Political Studies Association of Ireland Conference,  
University College Cork,  
20 October 2006**

**Not to be cited without the authors' permission.**

**Data used for this paper are drawn from a marked register analysis of turnouts for the 2002 General Election, arising from a joint research project between the Geary Institute in UCD, Dublin (Contact: Professor Richard Sinnott) and the National Centre for Geocomputation/National Institute for Regional and Spatial Analysis/Department of Geography, NUI Maynooth**

---

<sup>1</sup> Department of Geography/National Centre for Geocomputation/National Institute for Regional and Spatial Analysis, NUI Maynooth, Republic of Ireland. E-mail: [adrian.p.kavanagh@nuim.ie](mailto:adrian.p.kavanagh@nuim.ie)

<sup>2</sup> Geary Institute/Department of Politics, UCD Dublin

<sup>3</sup> National Centre for Geocomputation/National Institute for Regional and Spatial Analysis, NUI Maynooth, Republic of Ireland. E-mail: [stewart.fotheringham@nuim.ie](mailto:stewart.fotheringham@nuim.ie)

<sup>4</sup> National Centre for Geocomputation/National Institute for Regional and Spatial Analysis, NUI Maynooth, Republic of Ireland. E-mail: [martin.charlton@nuim.ie](mailto:martin.charlton@nuim.ie)

# A Geographically Weighted Regression Analysis of General Election Turnout in the Republic of Ireland'

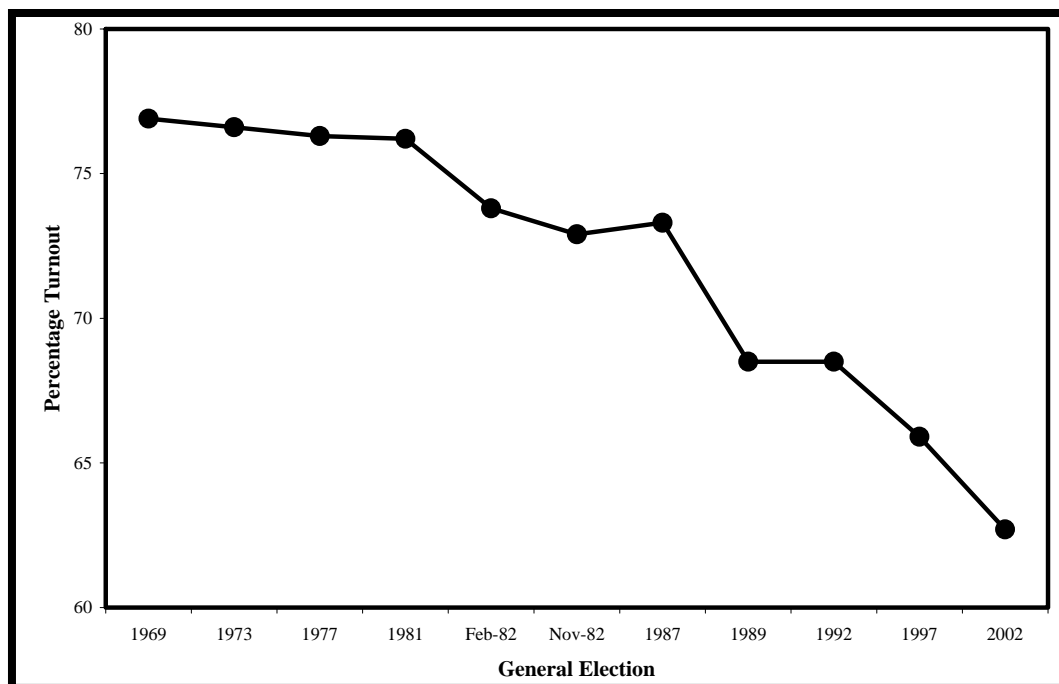


Figure 1: Voter turnout levels in Irish general elections, 1969-2002.

## Introduction

Turnout in the 2002 general election confirmed a downward trend in Irish voter participation levels, that first became evident in the early 1980s and was to culminate in the lowest turnout for an Irish general election since the foundation of the state (Figure 1). Given this context, voter turnout is a topic that requires further analysis within the Irish context, and two approaches to addressing this topic exist, with each approach having its own distinctive advantages and disadvantages. The surveying approach draws on individual-level data, and has the advantage of being able to draw on a wide range of variables, including social-psychological variables, and make direct inferences about the behaviour, and sources of the behaviour, of individuals. However, questionnaire surveys generally tend to overestimate turnout levels, with potential bias in survey response rates resulting in the under-representation of non-voters in survey samples. The second type of data – aggregate data – is subject to problems arising from the limited range of variables that can be accessed in seeking explanations of low turnout (usually limited to data that can be drawn from census analyses) and the cross-level inference problem that arises in any attempt to make inferences about individual-level behaviour from aggregate-level data (Achen and Shively, 1995). However, the big advantage of aggregate data lies in the accuracy of the estimation of the dependent variable (turnout) and in the potential it offers for spatial and census-based analysis of variations in the turnout variable. Lower levels of aggregation allow for a larger number of cases to be analysed and for more detailed pictures of spatial variations in turnout levels to be gleaned.

The most detailed aggregate-level analysis of turnout prior to publication of the Kavanagh, Mills and Sinnott (2004) paper in *Irish Geography* was a ward-level analysis of turnout in Dublin for the 1984 and 1989 European Parliament elections by Sinnott and Whelan (1992); while *Irish Voters Decide* (Sinnott, 1995) covered a series of elections from 1981 to 1992 at quite a high level of aggregation (Dáil constituencies) and involving a limited number of observations (approximately 40). Comprehensive turnout data was only widely available for constituencies until the *1997 Electoral Act* allowed for the release of marked copies of the electoral registers for local, European and general elections (but not for referendums) and, in doing so, greatly improved access to turnout data at much lower levels of aggregation. As a result of the 1997 Act, it is now possible to calculate accurate turnout figures for very

small geographical areas, such as townlands, streets or housing estates. Turnout for each area can be calculated by counting the total number of marks on copies of the marked register, indicating who has voted in that polling station, and relating these figures to the total numbers registered. The data can then be aggregated up to the electoral division (ED) level, which is suitable for computer cartography and for statistical analyses involving census data. Analysis of this kind of data has been carried out for a number of rural and urban constituencies in the 1999 local and European elections. This involved detailed spatial analyses of local election turnout rates in different rural and urban, middle class and working class, as well as inner city and suburban, contexts (Kavanagh, 2002a and 2002b). Subsequent to this research, a joint project, involving the Geary Institute, UCD and the National Institute for Regional and Spatial Analysis (NIRSA), NUI Maynooth, engaged in a similar, but far more comprehensive, marked register analysis of turnout levels in the 2002 General Election, as reported in Kavanagh, Sinnott and Mills (2004). This research involved the calculation of turnout figures for each electoral division in the Republic of Ireland, thus – with over 3,400 cases in all – forming the largest ever data set made available for an area-based analysis of turnout propensity (and indeed voting behaviour, in general) in Ireland. (More detailed spatial analysis, at the townland/estate/street level, was also carried out for the Laois-Offaly, Louth, Dublin Mid West and Dublin South East constituencies, as well as the Dublin Inner City.) A similar comprehensive marked-register based analysis of turnouts in the 2004 local, European and Citizenship Referendum elections was carried out by the Geary Institute and NIRSA. At present marked register turnout figures are available for each electoral division in Ireland for the 2002 and 2004 electoral contests (although there were some notable gaps in the data sets for some counties in 2004, most notably Galway County and Cork City), thus also allowing for the calculation of a turnout difference statistic for each electoral division. Indeed electoral division level turnout statistics are also available for the 1999 local elections in some areas, further allowing for the study of temporal trends in turnout levels for these areas.

*Problems with the electoral register:* One issue that needs to be addressed in relation to this data set however relates to the quality of the electoral register. There has been much attention in political circles and the media recently on the significant number of errors in the electoral registers, with a *Sunday Tribune* report finding that there were 800,000 more names on the register than should be there (McMorrow, 2006). This has, in turn, led to renewed efforts on the parts of local authorities to update their county's register ahead of the November deadline, but the fact that local authorities compile their county's register on an independent basis has led to further fears about inconsistencies in register quality across the state (see Figure 2, which portrays the degrees of register inaccuracy associated with different parts of the state). This is a serious concern for analysis such as this, which is based on a data set that is itself calculated on the basis of problematic electoral registers, but allowing for such flaws, the argument stands that this is the only means available for the calculation of highly detailed aggregate-level turnout data. Arguments that could be made that the spatial trends evident in the data are a product of inconsistencies in the quality of the electoral register, and that low turnouts in areas may be due, in part, to the names of large numbers of former residents being kept on the register for many years after they have left that area. However, a comparison between turnout and the degree of register inaccuracy finds that the electoral register problems are tending to dampen, rather than cause, the turnout differences that exist between different parts of the state. Many high turnout rural areas tend to have too many people on the register relative to the valid adult population, while the low turnout areas often tend to have fewer names on the register than their valid adult population would warrant. As such, the registration problem would seem to be hiding the degree of actual turnout differences that exist between rural and urban areas, should the valid adult population – and not the registered population – be used as the base to calculate percentage turnout figures from. Much of rural Ireland is shown to have turnout levels in excess of 75%, where the valid adult population is used to calculate these figures, while turnouts are shown to be low in the cities and their immediate commuter hinterlands.

### **A geography of turnouts for the 2002 General Election**

The purpose of the present paper is, ahead of the upcoming 2007 General Election, to revisit the 2002 General Election data set and to engage in a statistical analysis of the spatial trends that emerge from this

data. First, conventional ordinary least squares techniques will be employed, but, mindful of the problems associated with these use of these techniques in studies of non-stationary relationships, geographically weighted regression techniques will also be employed to take especial account of the manner in which the relationship between turnout and some causal factors may vary across space. But first we briefly need to present these spatial trends, and here a brief study of such spatial variations in turnout, summarising Kavanagh, Sinnott and Mills (2002) cartographical analysis in *Irish Geography*, will be offered.

Mapping the electoral division level turnout rates displays striking spatial patterns and underlines the strong rural-urban turnout variations in turnout in general elections (Figure 3(i)). Clusterings of low turnout electoral divisions are associated with the main urban centres, with low turnouts associated with the cities, and their commuter hinterlands, while some provincial towns, such as Castlebar, Ennis, Cavan Town and Athlone are also shown to have lower than average turnout levels. In the vast majority of cases, turnout levels in the provincial towns and their suburbs tend to be markedly lower than levels in their rural hinterlands. There is also an association between lower turnout and most coastal areas, with some exceptions, including the stretch of coast from Donegal to Ballina, Clew Bay and its environs, the Burren coast in Clare, and the Cork and Kerry coastlines. There are three distinct clusters of high turnout areas within the state:

- The “*north-west excluding Donegal*”: this area stretches westwards from the Louth border, through Monaghan and the northern parts of Cavan, spreading out as it goes westwards to include most of Longford, Roscommon, Leitrim, Sligo and Mayo, and the northern parts of county Galway.
- The “*south-midlands*”: this area incorporates western parts of Laois and southern parts of Offaly, and extends southwards to include south-east Galway, eastern parts of Clare and Limerick, most of Tipperary North and north-west Kilkenny.
- The “*south-west*”: this consists of the south-west of county Limerick, the western half of county Cork, and almost all of County Kerry excluding Tralee, Killarney and the peninsular littorals.

Significant turnout variations also exist at regional and sub-constituency levels, which tend to be obscured in the national picture, and this very much applies in the case of the Dublin region (Figure 3(ii)). Within Dublin, there is a large concentration of low turnout in the inner city area, as defined by the Royal and Grand Canals, as well as the Drimnagh/Crumlin and Ranelagh/Rathmines areas which are located to the south of this. As with its inner core, Dublin is also mainly characterised by low turnout areas on its outer limits, with these low turnout clusters forming an approximate arc from the Darndale area in the north-east, through Ballymun, Mulhuddart and parts of Blanchardstown, southwards through Clondalkin, Cherry Orchard and Ballyfermot, into the West Tallaght area. Completing this arc is another area of low turnout in the extreme south of the region, including the Ballinascorney, Boheernabreena and Tibbradden areas in the foothills of the Dublin Mountains, areas that have experienced considerable increases in their population recently. This low turnout inner city areas, by contrast, are flanked on the north by a belt of high turnout, stretching westwards from Clontarf, Sutton and Howth on the east coast, through Drumcondra and parts of Cabra, into Castleknock and Lucan, and on the southside by fairly contiguous high turnout areas, running from Stillorgan and Foxrock westwards through Dundrum across to the Templeogue and Terenure areas. These high turnout inner suburban areas tend to be middle class and settled areas whereas the low turnout areas tend either to be largely working class areas or else areas that have recently experienced rapid population expansion.

### **Ordinary least squares statistical analyses**

Based on these spatial trends, it could be hypothesised that turnout in 2002 was shaped by a variety of demographic, socio-economic and cultural factors, with it being possible to draw such variables from the Small Area Population Statistics for the 2002 Census of Population for the purposes of using these in statistical analyses to determine the degree to which they may have influenced turnout levels in the 2002 General Election. Correlation analyses involving the turnout difference variable and a range of census variables were carried out involving figures drawn from all of the electoral divisions within the Republic of Ireland (3,406 cases), with the exception of the small number of cases, or electoral divisions (eight in all), for which marked copies of the electoral register were not provided and hence it was not possible for marked register turnout data to be generated.

<b>Factor</b>	<b>Turnout, 2002 General Election</b>
Turnout in 2004 local elections	0.77**
Males	0.31**
18-24 years old (as % of VAP)	-0.42**
25-44 years old (as % of VAP)	-0.24**
45-64 years old (as % of VAP)	0.30**
65+ years old (as % of VAP)	0.26**
Social Class Groups 1 and 2	0.03
Social Class Groups 5 and 6	0.05**
Left school before 15 <sup>th</sup> birthday	0.16**
No formal, primary or lower secondary education	0.22**
Upper secondary education	0.05**
Third level education	-0.29**
Labour force participation rate	-0.08**
Unemployment rate	-0.23**
Lone parent households	-0.28**
No car household	-0.44**
Occupation: Agriculture	0.48**
Living in a flat/apartment	-0.44**
Tenure type: Owner occupancy	0.55**
Tenure type: Local authority rented	-0.39**
Tenure type: Private rented	-0.44**
Owner occupancy – no mortgage	0.55**
Owner occupancy – mortgaged	0.02
Residing in housing built after 1991	-0.09**
Non Irish/UK nationals	-0.41**
Members of Traveller community	-0.15**
Catholic religion	0.19**
Time travelled in daily commute to work over one hour and a half	-0.08**
Leave home for work before 07.30hrs	-0.20**
Distance travelled in daily commute to work over 30 miles	0.15**
Living at different address one year earlier	-0.43**
Social Deprivation composite variable	-0.05**
Number on electoral register as compared to valid adult population <sup>5</sup>	0.12**
Quality of the electoral register <sup>6</sup>	-0.06**

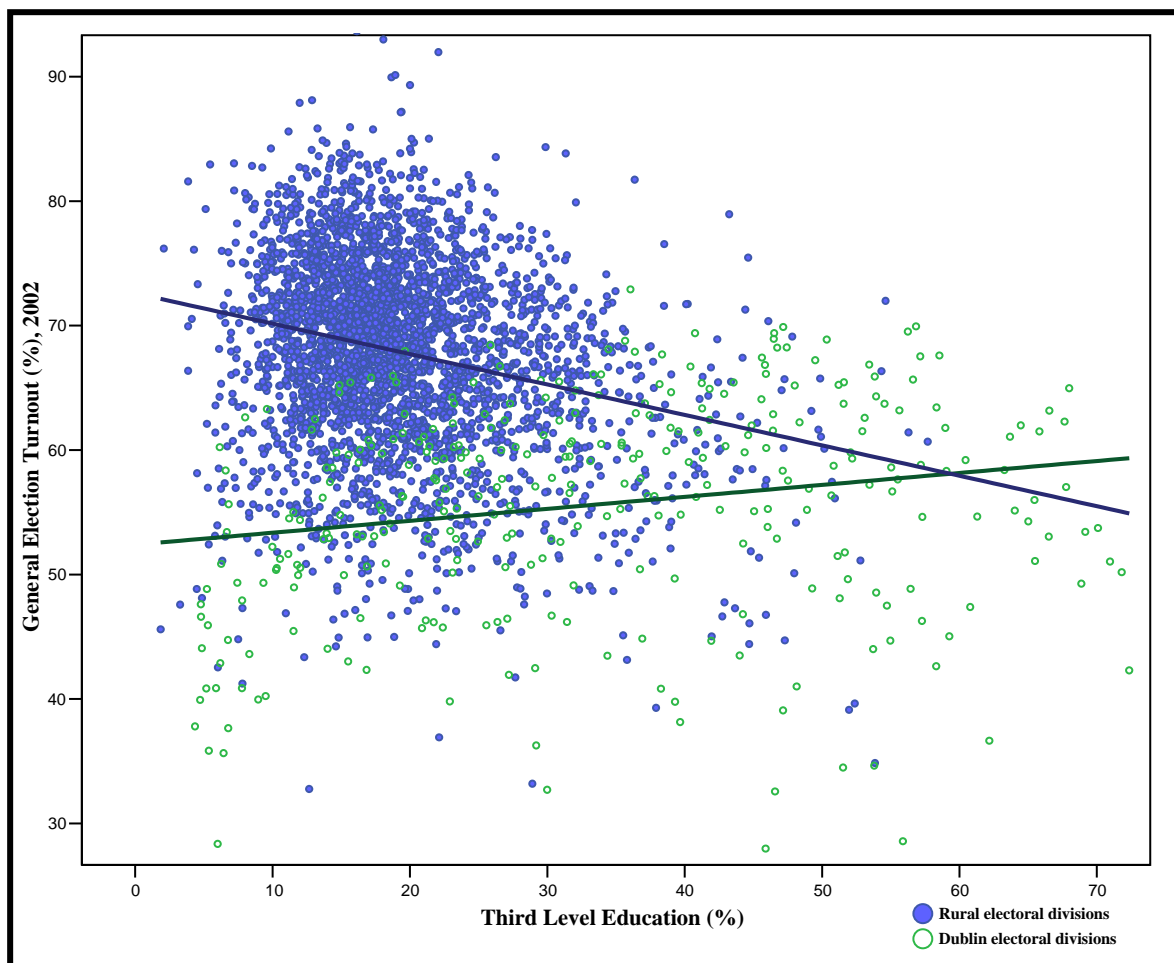
**Table 1: Correlations between general election turnout and socio-economic and demographic variables, as drawn from Census 2002, in the Republic of Ireland** [\*\*\*  $p < 0.01$ , \*  $p < 0.05$ .]

Arising from the correlation analyses in Table 1 above, general election turnout can be inferred to be strongly related to gender (positive correlation with the percentage of males in an electoral division) and age (positive correlations with older age groups, negative with younger age cohorts) differences. Population change and residential mobility are also seen to shape turnout, with a negative correlation between turnout and the percentage of people living at a different address the year before the census (and general election) and in a new house (built after 1991), while negative associations are also seen to exist with commuter-type patterns, such as increased levels of time spent in travelling to work, and also earlier departures from home in the morning commute to work. (Interestingly, the distance to work factor does not

<sup>5</sup> The positive correlation here infers that turnouts were higher in areas where registers were over-represented (more people on the register than the valid adult population) and lower in areas where the register tended to be under-represented (more people on the register than the valid adult population).

<sup>6</sup> Here, the register term is taken as the absolute variance between the numbers on the register and the valid adult population, based on the Census 2002 figures, and the negative correlation infers that turnouts tended to be lower in areas where the register quality was the most problematic.

behave in a similar manner; the commuting factors that appear to enhance low turnout propensity are those related to time travelled and time of departure.) Housing tenure is also significantly correlated with general election turnout; negative correlations exist between turnout and the percentage of people living in flats and apartments, and rented housing – both private rented and local authority rented – while a positive correlation exists with the owner occupied housing variable – though the association between turnout and mortgaged owner occupied housing proves to be a weak and statistically insignificant factor. The associations between class and turnout are not as clear cut as one would expect based on the findings of the electoral literature and the trends observed in the Dublin turnout geography, particularly in the case of the correlations with the social class groupings. The relationship between turnout and education is also the converse of what would be expected from other electoral studies which suggest that turnout propensity increases in line with educational levels. The findings in Table 1 suggest an association between educational disadvantage and higher turnout, and an association between lower turnout and third level education.



**Figure 4: Scatterplot showing relationship between general election turnout and third level education, contrasting relationship found in Dublin with that for rest of the state, with separate regression lines for Dublin (green) and rural (blue) electoral divisions.**

Previous research (Kavanagh, 2006, Kavanagh, Fotheringham and Charlton 2006) identified how the relationships between general election turnout and a range of causal factors differ significantly when analyses are restricted to smaller study areas, most notably urban Ireland (Dublin and the other major cities) and rural Ireland (taken to be the rest of the state). Different relationships were observed between turnout and a range of factors related to gender, housing tenure, social class and education when the study was based solely on rural-based electoral divisions, as against an urban electoral division-based study. This suggests that the relationships between turnout and different predictor variables may vary across space, a problematic issue when ordinary least squares statistical techniques, which assume the relationships

between variables to be stationary (not varying across space), are employed, as is the case in the regression models in Table 2, below.

Table 2 contains summary statistics drawn from four different regression models, in which the dependent variable is percentage turnout in the 2002 General Election for all three models. The first model involves a single predictor, a composite social deprivation variable, calculated arising from a factor analysis involving the following variables: social class groups 5 and 6, unemployment, lone parent household and educational disadvantage. In the second model, a multivariate analysis is involved, involving five different predictor variables; the percentage living in owner occupied housing, the percentage of the electorate aged 65 years, and over, the percentage in social class groups 1 and 2, the percentage of males, and the percentage who completed full time education with a third level education standard.

	<b>Model 1</b>	<b>Model 2</b>	<b>Model 3</b>	<b>Model 4</b>
<b>Number of cases</b>	<b>3,406</b>	<b>3,406</b>	<b>3,406</b>	<b>3,406</b>
<i>Intercept</i>	<b>66.76</b> (449.66)	<b>29.09</b> (10.11)	<b>20.17</b> (8.13)	<b>36.33</b> (44.40)
<i>Social Deprivation composite factor</i>	<b>-0.42</b> (-2.82)			<b>0.97</b> (7.58)
<i>Owner occupied housing</i>	.		<b>0.25</b> (22.05)	<b>0.36</b> (38.83)
<i>% Electorate aged 65, and over</i>	.		<b>0.35</b> (15.59)	
<i>Social Class groups 1 and 2</i>	.		<b>0.10</b> (4.64)	
<i>Males</i>	.	<b>0.76</b> (14.27)	<b>0.38</b> (7.96)	
<i>Third level education</i>	.	<b>-0.20</b> (-13.11)	<b>-0.16</b> (-7.37)	
<i>Owner occupied housing (mortgaged)</i>	.	<b>0.08</b> (6.05)		
<i>Quality of electoral register</i>				<b>-0.03</b> (3.14)
<i>Akaike Information Criterion</i>	<b>24,440.54</b>	<b>23,922.58</b>	<b>21,644.08</b>	<b>23,196.19</b>
<i>Adjusted R<sup>2</sup> value</i>	<b>0.002</b>	<b>0.144</b>	<b>0.560</b>	<b>0.310</b>

**Table 2: Aggregate data analyses of turnout in 2002 General Election by electoral division.**

[Note: The main entry for each variable is the b coefficient, the italicised figure beside it (in brackets) is the t-value. T-values in excess of 2.02 are significant at p=0.05.]

Table 2 shows the results of these ordinary least squares regression analyses of general election turnout. What is particularly evident here is the limited explanatory power associated with two of these models possess; alone the social deprivation factor is shown to account for just 0.2% of the variance in the turnout data set, while the three variables in the second model (males, third level education and mortgaged owner occupied housing) are shown to account for just over 14% of the variance in the turnout variable. The negative coefficient value for the social deprivation factor in Model 1 (with the t-value inferring a statistically significant relationship) infers that increasing levels of social deprivation will result in lower general election turnout levels, on average, within the Republic of Ireland, but based on this analysis social deprivation is not seen as having a significant degree of influence on turnout patterns. All the three variables included in the second model are statistically significant, based on the size of their respective t-values, with the negative relationship with the third level education variable inferring an association with lower general election turnouts, while the positive coefficients associated with the male and mortgaged owner occupied housing factors associating these with higher general election turnouts. Model 3, based on a comparison of the r-square values and the akaike information criterions, is the most robust of the four models, with the five predictor variables seen to account for 56% of the variance in the turnout data set. The most significant of these variables is the owner occupied housing variable, which is positively associated with turnout as is the next most significant factor – the percentage of the electorate aged 65, and over. Two of the other predictors in this model – the percentage of males in the population and Social Classes 1 and 2 – are likewise positively associated with general election turnout, while the final variable – third level education – is negatively associated with turnout. Finally, Model 4 contains the owner occupied housing, social deprivation and electoral register variables and proves to be a less powerful model than Model 3, accounting for 31% of the variance in the turnout data set. The negative coefficient for the electoral register coefficient suggests that the recorded turnout rate will be lower in areas which have the

greatest discrepancies, in absolute terms, between the numbers on the register and the valid adult (over 18) population. What is notable here is the positive b-coefficient for the social deprivation factor, suggesting a positive relationship between turnout and deprivation, once housing tenure and register quality is controlled for.

Why do the models, to varying degrees, prove to be so ineffective? First, the models may be omitting some other key census based variables that would improve the model performance if they were also included as predictor variables. However, further models involving other such variables involve only minimal degrees, if any, of improvement in the model performance. A more likely reason would be that a large proportion of the turnout change may be accounted for by other factors, which are not measured by census statistics, mainly relating to the local political context and the impact on turnout of the ‘friends and neighbours’ and ‘neighbourhood’ effects, as well as political campaigning and local media focus. However, the manner in which the relationships between turnout and certain causal factors tend to differ when studies are carried out in different areas (such as differences between urban and rural based studies) points towards the limitations of ordinary least squares regression analyses, in their over-reliance on producing global, or average, statistics, and their implicit assumptions that the relationships between variables will be stationary across space (i.e. the relationship between the variables is the same everywhere in the study area). There is a need for a more spatially-sensitive statistical technique that will be able to take account of the different relationships that may exist between turnout and other factors in different areas, especially as social processes, including those relating to voter behaviour, would generally be expected to be non-stationary. The next step in this research will be to employ such a technique, namely geographically weighted regression (Fotheringham, Brunson and Charlton, 2002), to try to better explain spatial differences in general election turnout in the Republic of Ireland.

### **Geographically weighted regression analyses**

These first few paragraphs offer a very brief introduction to geographically weighted regression techniques, and a more detailed discussion of these may be found in Fotheringham, Brunson and Charlton (2002). Geographically weighted regression is a technique for exploratory spatial data analysis, which tries to take account of spatially varying relationships in a way that traditional ordinary least squares techniques cannot (as evident in spatial autocorrelation the data sets of these models). In ordinary least squares techniques the aim is to calculate a global, or average, b-coefficient terms for the predictor variables, for instance to calculate a value for the  $\beta_0$  and  $\beta_1$  terms in the model below:

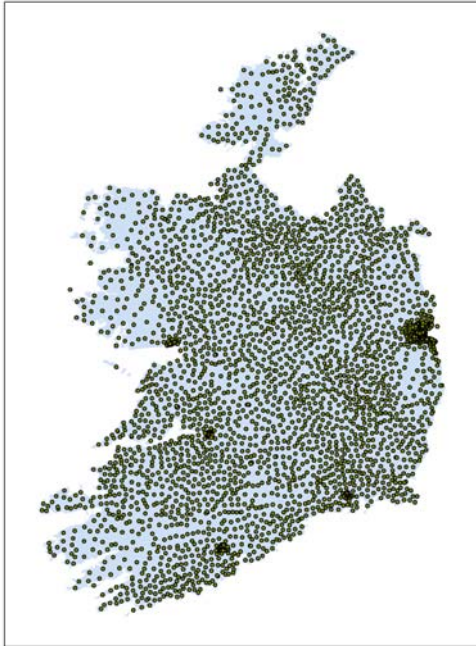
$$y = \beta_0 + \beta_1 x_1 + \varepsilon \quad (1)$$

No measure of how the relationship between the dependent and predictor variables can be captured in this global model, and such geographical variations instead will be expressed in the error term,  $\varepsilon$ , and the set of residual values. In geographically weighted regression, however, separate b-coefficient values will be calculated for each point in the data set; for instance at a point (u,v) the model can be rewritten as:

$$y(u,v) = \beta_0(u,v) + \beta_1(u,v)x_1 + \varepsilon(u,v) \quad (2)$$

Thus instead of calculating single  $\beta_0$  and  $\beta_1$  as in the first model (1), the parameter estimates in geographically weighted model are local rather than global statistics, and allowed to vary locally, with the model producing separate  $\beta_0(u,v)$ ,  $\beta_1(u,v)$  terms for each point in the data set. These sets of local parameter estimates are calculated by using a specific weighting scheme, in which observations near the point are allowed to have greater influence on the parameter estimates for that point than observations taken at points that are much further away. (This is very much in line with Tobler’s (1970: 236) first law of geography; that “*everything is related to everything else, but near things are more related than distant things*”, a law that global, or ordinary least squares, regression models do not take account of, leading to spatial structure in the residuals when the observations come from areal units) The weight calculation for

the  $i$ th observation, for instance, would be:  $w_i(g) = \exp(-d/h)^2$ , in which where  $d$  is the Euclidean distance between the location of observation  $i$  and location  $g$ , and  $h$  is a quantity known as the bandwidth. Data points will be weighted relative to their distance from the regression point, and so points close to the regression point will be more heavily weighted than those data points which are further away. The result is a series of parameter estimates arising from a series of local calibrated regression models, and these may



be mapped to produce surfaces of parameter estimates, or any other locally generated statistical measures arising from the regression model. Data measurements drawn from outside a specific distance from specific regression points will not be included in the local regression model at that point, and hence local parameter estimates for the different points will only be generated from data measurements drawn from points located within a specific area encircling that regression point, referred to as the spatial kernel. These spatial kernels may be similar in extent, or fixed, for each regression point within the data set, but this means that parameter estimates will be based on significantly smaller data sets in areas where data points are less densely clustered. This is particularly an issue for this study, as the data points used are the centroids of electoral divisions, which are densely clustered within urban regions, such as, most notably, Dublin City, and significantly less densely clustered in more rural areas in the west of Ireland (as illustrated by the adjacent centroids map). Thus, the spatial kernels need to be flexible, or adaptive, being relatively smaller in extent for regression points located in

urban parts of the study area, where data points are densely clustered, and larger in extent for regression points located in the more rural parts of the study area.

For the purposes of this paper, to allow for a clearer illustration of the technique, a geographically weighted study of just one of the models referred to above (Model 1), involving just one predictor variable, social deprivation, will be offered here. Based on the negative  $b$ -coefficient for the social deprivation variable in the initial, ordinary least squares, regression models, increased levels of social deprivation would be expected to be associated with higher local election turnouts, relative to those for general elections. This model was found to have a very limited degree of explanatory power, as indeed were all the other models studied in the previous section. However, when the social deprivation composite variable is included as a predictor of turnout change in a geographically weighted regression model, there is a notable improvement in model performance. The adjusted  $r$ -square value increases from 0.002, as was the case for the global regression model, to 0.473, while the akaike information criterion is significantly smaller, reduced from 24,440.54 for the global model to 22,368.37 for the geographically weighted model.

	Model 1	Model 2	Model 3	Model 4
<b>Akaike Information Criterion</b>				
<i>OLS Model</i>	24,440.54	21,644.08	23,922.58	23,196.19
<i>GWR Model</i>	22,368.37	20,386.34	22,097.26	21,600.65
<b>Adjusted <math>R^2</math> value</b>				
<i>OLS Model</i>	0.002	0.560	0.144	0.310
<i>GWR Model</i>	0.473	0.724	0.528	0.592

**Table 3: Comparison of akaike information criterion and adjusted  $r$ -square value terms for ordinary least squares and geographically weighted regression models**

As illustrated by Table 3, a geographically weighted regression approach to the other models studied in Table 2 above also results in an improvement in the ‘goodness of fit’ of these models, with significant reductions in the size of the akaike information criterion in all four cases, as well an increased in the adjusted  $r$ -square values.

Furthermore, a mapping of the standard residual score for this model shows that there are fewer extreme residual values, as against the trend for the global model, while the problem of spatial autocorrelation in the residual data set is also addressed as the larger residuals are more dispersed about the study area as against the clustering of large positive and negative residual scores in the original, ordinary least squares, regression model (Figure 5). The clustering of large positive residual scores, for instance, in the western part of the state and large negative scores in the east for the ordinary least squares model, as illustrated by Figure 5(i), is not as apparent in the map of residuals for the geographically weighted model (Figure 5(ii)). (There is admittedly some degree of spatial autocorrelation evident in Figure 5(ii) and this could be picking up other factors, which are not included in the model but affect turnout, such as local candidate influences.) There are also fewer extreme residual values evident in Figure 5(ii). Finally, tests for the spatial variability of the social deprivation and intercept parameters, using a Monte Carlo significance test procedure, finds both these to be statistically significant; the intercept map being significant at the 0.1% level ( $p=0.00000$ ) and the map for the spatial deprivation factor significant at the 5% level ( $p=0.02$ ). This confirms that the relationship between the social deprivation factor and turnout change is a non-stationary one, and hence more suited to geographically weighted, as opposed to ordinary least squares, regression modelling.

While the ordinary least squares regression model only produced a single average, or global, parameter estimate for the social deprivation factor ( $b = -0.42$ ) as noted above, the geographically weighted model produced parameter estimates, both for the intercept and the social deprivation factors, for each data point (or for each electoral division) in this particular model. These parameters were mapped (Figure 6). The map of parameter estimates for the social deprivation factor (Figure 6(ii)) shows inverse relationship between this factor and general election turnout holding in different areas on the map (as delimited by the yellow/green shading), including the major cities and their commuter hinterlands and also the Shannon and Barrow river basins. Positive relationships are shown to exist (as shaded in blue) in the south-west of Ireland, the Louth and northern Meath area, Wicklow, Sligo-Leitrim, and parts of Galway County.

The dark yellow shaded areas on the map of t-value scores (Figure 7) for the social deprivation factor pinpoint areas characterised by particularly strong inverse relationships between social deprivation and general election turnout. The most significant concentrations of these negative t-values are associated with the large urban centres of Dublin and Limerick, and their immediate hinterlands, inferring that social deprivation has a significantly negative influence on general election turnout levels in these areas. Similarly, the map of t-values infers that strong and significant inverse relationships exist between deprivation and turnout in Cork City and its hinterland, the coastal fringes of the West, including western parts of Donegal, Mayo and Galway counties, Athlone and its hinterland, and Waterford and the basin of the River Barrow. In these areas, as in the other parts of the map which are shaded yellow, higher levels of social deprivation would be inferred to result in lower general election turnouts, as would be the general view of much of the electoral literature. However, as denoted by the blue shaded areas on the map (Figure 7), there are some parts of the state where the relationship between general election turnout and social deprivation is positive – the greater the degree of deprivation in an area, the higher the turnout in that area – and this positive relationship is seen to be statistically significant in the north Kerry and Louth areas, as well as in a smaller area, focused on the borders of north-east Roscommon and south-west Leitrim. It is notable that all of these are areas where Sinn Féin attained strong electoral support levels in the 2002 General Election – Martin Ferris in Kerry North and Arthur Morgan in Louth achieved sufficient support levels in these constituencies to gain a Dáil seat for the party, while the Ballinamore area in Leitrim was also a strong support area for the party in that election (based on analysis of tally figures for those elections and the party's strong performance in Ballinamore in the subsequent local elections, where their candidate topped the poll and won a council seat). It is also worth noting that there are large tracts across the map (particularly in rural Ireland) where the relationship between general election turnout and social deprivation is shown to be a weak and insignificant one. This suggests that class differences have no significant bearing on turnout variation in these areas and there may be a number of reasons for this phenomenon. First, given the clientelist nature of Irish politics, the rural working classes may be as motivated to vote as rural professionals as their greater need for lack of information as to how to access

entitlements arising for poorer educational standards means that they are often reliant on their local politicians for assistance. The rural working class also tends to be less residentially mobile than the professional class would be and their turnout decisions thus more likely to be influenced by candidate, or “friends and neighbours” influences due to their stronger roots in their home areas.

The map of the local r-square values in Figure 8 illustrates that a particular concentration of high values is associated with much of the Dublin region and its commuting hinterland, but with a specific focus on the outer edges of the Dublin commuter belt, including areas such as Louth, north-west Meath, the east Midlands and northern parts of Carlow and Kilkenny. Similarly, concentrations of high local r-square values are to be found in the cities of Cork, Limerick and Galway, as well as their commuting hinterlands (including the Connemara region in Galway County, which would form part of the outer edges of the Galway City commuter belt). By contrast, this model is seen to account for very small degrees of turnout variation in other parts of the state, namely the more rural areas. The association between urban areas and stronger model predictive power is to be expected based on previous research, which found that socio-structural factors have a significantly greater bearing on turnout variation in urban Ireland than in rural parts of the state (Kavanagh, 2002b). One factor that may account for spatial differences in terms of the local r-square values is the greater bearing that candidate, or friends and neighbours, influences may on turnout variation in rural areas, as opposed to urban areas. More intangible influences could also be involved in accounting for such differences, namely those related to levels of community stability or levels of politicisation. Rural areas tend to be characterised by more politicised cultures. As might be envisaged by the neighbourhood effect concept, the highly alienated culture of social deprived urban areas may act to ‘convert’ people to non-voting behaviour, while the more politicised cultures of rural communities will generally encourage poorer members of rural communities to vote. Moreover, as the spatial segregation of classes, associated with urban Ireland, is not as pronounced in rural areas, canvassers will not bias their activity towards the rural middle classes to the extent that canvassers in urban areas generally tend to focus their canvassing efforts on high turnout, middle class areas (Kavanagh, 2002b). The combination of these factors mean that the rural working classes are much more likely to be personally canvassed at election time than the urban working classes are, linking in with Green and Gerber’s (2004) findings that door-to-door canvassing is the most effective form of voter mobilisation. (This factor also accounts for the relatively low referendum turnouts that have been observed for rural areas, because, as interview analyses have suggested (Kavanagh, 2002b), party organisations in rural areas generally do not make a concerted effort to get the vote out for these contests as opposed to the considerable efforts made to mobilise voters in local and general elections.) Thus class has a significant impact on canvassing strategies in urban areas, while being relatively insignificant in shaping rural canvassing strategies, and this may also, in part, account for why socio-structural influences, such as levels of social deprivation, tend to have a greater bearing on variance in urban turnout models, as opposed to those for rural areas.

### **Concluding words**

Agnew (1987, 1996) suggests that geographical context acts to shape political behaviour and the manner in which different factors may relate to this, and this contention is particularly key to an analyses of Irish turnout levels, given the high degree of localism associated with Irish electoral behaviour. A spatial, or contextual, viewpoint remains central to studies of voter choice and how electoral systems operate, because, as stressed by Johnston and Pattie (2004: 50), “place matters in those processes”. A place-based perspective allows for the “historical specificity and uniqueness of places” (Agnew 1987: 42) to be taken account of in studies of Irish electoral behaviour, as also highlighted in UK research by Johnston et al. (2001), and shows how general election turnout patterns may be shaped by a “variety of influences emanating from a range of geographical scales” (Agnew 1996: 130). While it is shown that socio-structural factors may shape support levels for parties and turnout propensity to some degree, especially in more urban areas more localised, or place-specific, factors, such as the impact of neighbourhood or ‘friends and neighbours’ effects, also need to be taken account of (Pattie and Johnston, 1999). To fully understand what shapes the voting behaviour of the Irish electorate, analyses will, to a significant degree, need to be geographical and rooted in local places.

Given that research has shown that relationships between turnout propensity and different causal factors, such as class, education levels and gender, vary significantly across space in the Republic of Ireland, ordinary least squares techniques were seen to be ineffective in analysing such relationships and it was argued that more spatially sensitive statistical techniques might prove more effective in explaining turnout change, and other forms of voting behaviour (Kavanagh, 2006, Kavanagh, Fotheringham and Charlton, 2006). Fotheringham, Charlton and Brunson's (2002) geographically weighted regression technique allows the development of statistical models that can take account of such spatially varying relationships and improve model performance when studying social behaviour, and this proves to be the case for the modelling of turnout behaviour. Based on the uncovering of local peculiarities by the geographically weighted models, a fuller understanding of the contexts that shape electoral participation rates may be gleaned. However, while these techniques bring about a significant improvement in model performance, a significant degree of variance in the turnout change variables still remains unaccounted for, which may, in part, be addressed by further refinements of the turnout model. The remaining variance may be addressed by highly detailed case studies relating to areas where unusual relationships with turnout behaviour are uncovered, or where high degrees of residual variance still remain to be accounted for. Such studies may also be employed to determine whether patterns of non-voting are related more to accidental non-voting, rather than long-term or deliberate non-voting, in specific contexts (Marsh, 1991), which may help direct efforts to improve turnout as to whether the key focus should be on the facilitation or the mobilisation of voters in these specific geographical contexts.

Geographically weighted regression promises to be a useful tool in terms of developing on ecological analyses of voting behaviour in the Republic of Ireland, particularly given how the candidate-centred and highly localised nature of Irish politics, arising in part from the PR-STV electoral system used within the state. The relationship between voting behaviour patterns and the factors that may shape this, such as levels of economic well-being or social deprivation as focused on in this paper, can vary considerable across the Irish political landscape, and the technique is particularly apt in addressing this phenomenon and making for stronger statistical models. The results arising from this analysis in turn should lead on to further, more qualitative, case studies of those regions that are seen to warrant such study from the analysis, making for a more detailed, context-centred, and data-driven ecologically-based understanding of Irish voter behaviour, than can greatly complement the findings arising from individual level analyses, such as the Irish National Election Study.

### **Turnout data**

This data used in this paper arises from two different projects involving marked register analyses of turnout levels in the 2002 General Election (carried out during Summer 2003 by Adrian Kavanagh, Catherine Duffy and Cormac Walsh in NUI Maynooth). This was a joint research project involving the Geary Institute, UCD, Dublin (lead researcher: Prof. Richard Sinnott), and the Department of Geography/National Institute for Regional and Spatial Analysis/National Centre for Geocomputation, NUI Maynooth (lead researcher: Adrian Kavanagh).

### **References**

- Achen, Christopher H. and Shively, W. Philips (1995) *Cross-Level Inference*. Chicago: University of Chicago Press.
- Agnew, J. (1987) *Place and politics: The geographical mediation of state and society*. Boston: Allen & Unwin.
- Agnew, J. (1996) "Mapping politics: how context counts in electoral geography", *Political Geography* 15 (2), 129-146.
- Fotheringham, A.S., Brunson, C., and Charlton, M. (2002) *Geographically Weighted Regression: The analysis of spatially varying relationships*. Chichester: Wiley.

- Green, D.P. and Gerber, A.S. (2004) *Get out the vote: How to increase voter turnout*. Washington DC: Brookings Institution Press.
- Johnston, R.J. and Pattie, C. (2004) 'Electoral geography in electoral studies: Putting voters in their place' in Barnett, C. and Low, M. (eds) *Spaces of Democracy: Geographical perspectives on citizenship, participation and representation*, London: Sage, 45-66.
- Johnston, R.J., Pattie, C.J., Dorling, D. F. L., MacAllister, I. Tunstall, H. and Rossiter, D. J. (2001) "Housing tenure, local context, scale and voting in England and Wales, 1997", *Electoral Studies* 20 (2), 195-216.
- Kavanagh, A. (2002a) *Unequal participation – Unequal influence: Voter participation and voter education in Dublin's South West Inner City*, Dublin: South West Inner City Network.
- Kavanagh, Adrian (2002b) *Social deprivation, political alienation and community empowerment*, Unpublished PhD thesis, Department of Geography, NUI Maynooth.
- Kavanagh, A. (2006) 'Second order elections and the Republic of Ireland: A spatial perspective on turnout differences between the 2002 General Election and 2004 local elections'. *56th Annual Conference of the Political Studies Association (PSA)*, University of Reading (3-6 April 2006).
- Kavanagh, A., Mills, G. and Sinnott, R. (2004) "The geography of Irish voter turnout: A case study of the 2002 General Election", *Irish Geography*, 37(2), 177-186.
- Kavanagh, A. Fotheringham, S. and Charlton, M. (2006) 'A Geographically Weighted Regression Analysis of Election Specific Turnout Behaviour in the Republic of Ireland'. *Elections, Public Opinion and Parties 2006 Conference of Irish Geographers*, University of Nottingham (8-10 September 2006).
- Marsh, M. (1991) "Accident or design? Non-voting in Ireland", *Irish Political Studies* 6, 1-14.
- McMorrow, Conor (24 September 2006) Roche under fire for 800,000 discrepancy of electoral register, *Sunday Tribune*.
- Pattie, C. and Johnston, R. (1999) "*Context, conversation and conviction: Social networks and voting at the 1992 British General Election*", *Political Studies* 47, 977-889.
- Sinnott, Richard (1995) *Irish voters decide: Voting behaviour in elections and referendums since 1918*. Manchester and New York: Manchester University Press.
- Sinnott, R. and Whelan, B. (1992) "Turnout in second order elections: The case of EP elections in Dublin, 1984 and 1989", *The Economic and Social Review* 23(2), 147-166.
- Tobler, W.R. (1970) "A computer movie simulating urban growth in the Detroit region", *Economic Geography* 46(2), 234-240.