Understanding spatial variations in the impact of accessibility on land value using geographically weighted regression

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Dr Hongbo Du and Professor Corinne Mulley
Chair in Public Transport | Institute of Transport and Logistics Studies
The University of Sydney
corinne.mulley@sydney.edu.au
http://sydney.edu.au/business/itls

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Outline

- The impact of new transport infrastructure on accessibility
- Possible methodologies for measuring impacts
- Geographically Weighted Regression
  - methodology
- The Tyne and Wear case study
- The GWR model: results
- Conclusions

Source: www.pteg.net

Impact of public transport infrastructure on residential land value

- New infrastructure changes accessibility
- Changes value of unimproved land

BUT

- Changes in improved land observed

Source: photos.com

Taking account of improvements to land value

- House prices include
  - Land
  - Improvements to land
- Methodology needs to standardise for improvements to identify unimproved land value

Source: blog.evolutionrealty.com.au

Possible methodologies

- Comparison method
  - Fails to capture complexities which make up house prices
- Hedonic modelling
  - Common approach
  - Approaches to variations across space
- Spatial modelling

Geographically Weighted Regression (GWR)

- Spatial modelling approach
  - ‘global’ model equivalent to Ordinary Least Squares/hedonic modelling
  - ‘local’ model takes account of geographical relationships
- Outputs mapped

Geographically Weighted Regression (GWR)

In OLS regression, the relationships being modelled are assumed to be constant across the whole study area.

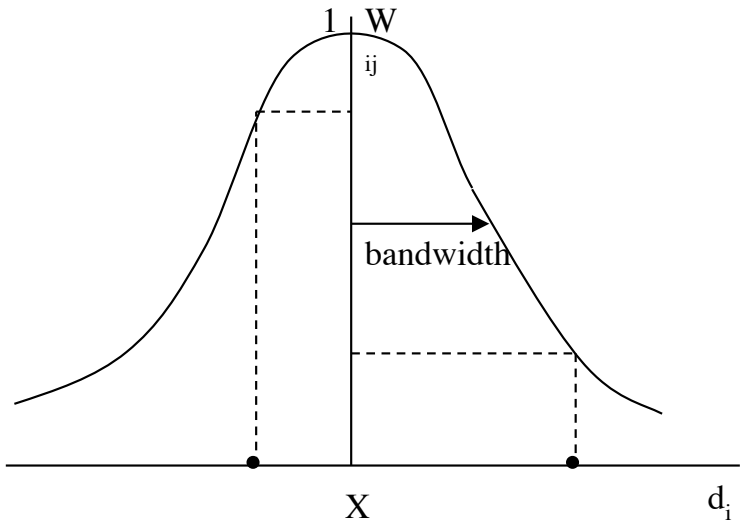
OLS Regression $$Y_i = \beta_0 + \sum_k \beta_k X_{ik} + \varepsilon_i$$

GWR $$Y_i(u_i v_i) = \beta_0 (u_i v_i) + \sum_k \beta_k (u_i v_i) X_{ik} + \varepsilon_i$$

In GWR, relationships are modelled using the location of the observation (X and Y) in comparison to its neighbours.

The neighbouring observations are given more weight than those further away.

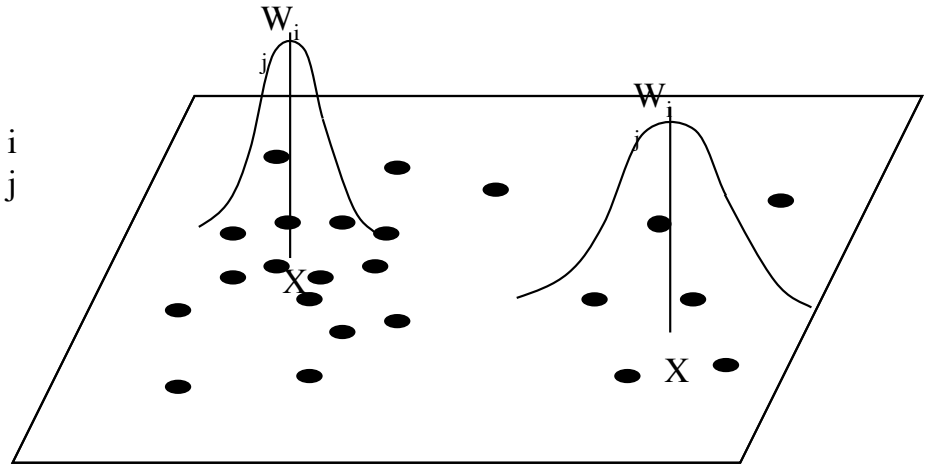
GWR spatial considerations



X regression point
● data point

Wij is the weight of data point j at the regression point i

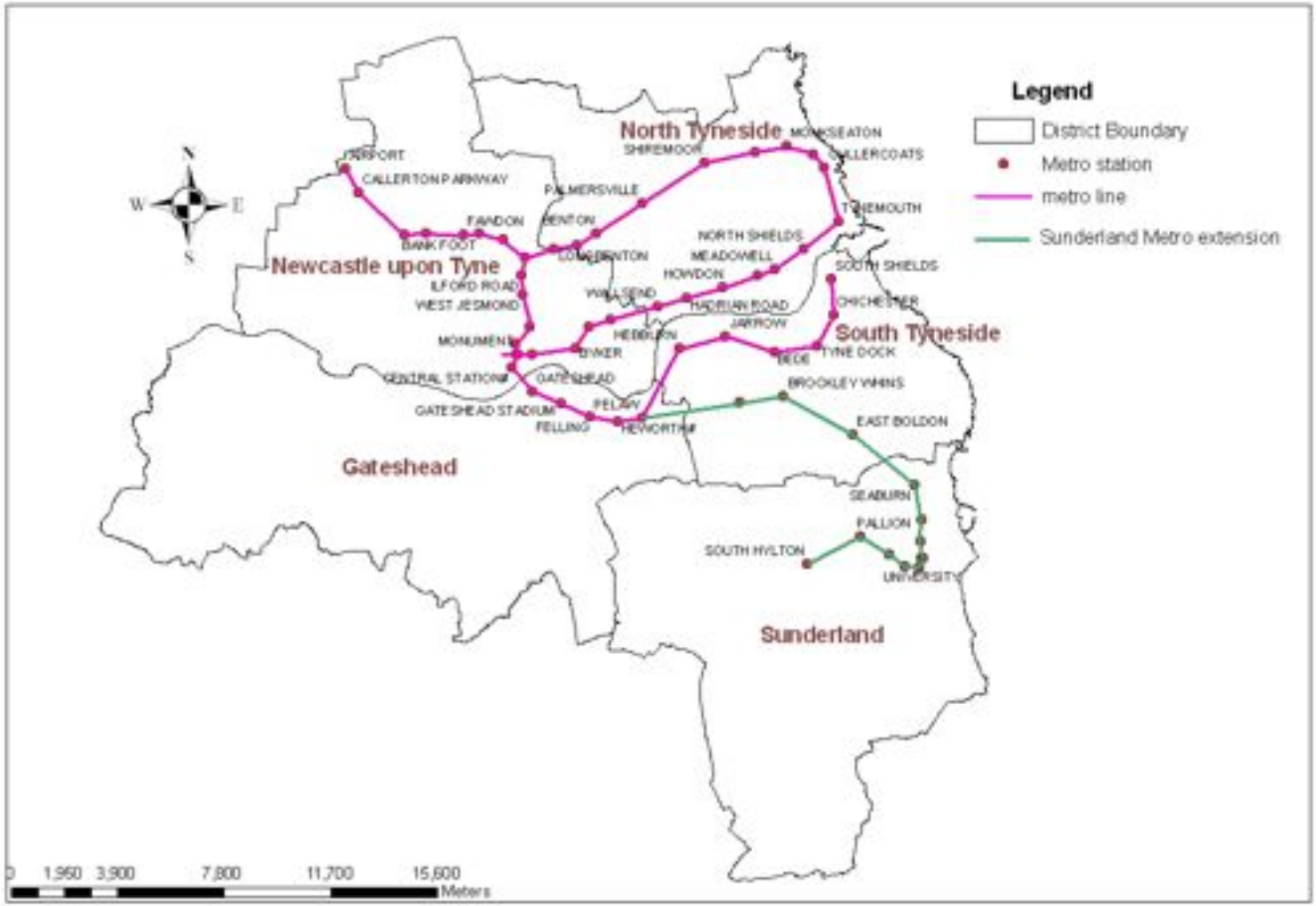
dij is the distance between regression point i and data j



X regression point
● data point

Source: Fotheringham et al. (2002) *Geographically Weighted Regression*, pp. 44

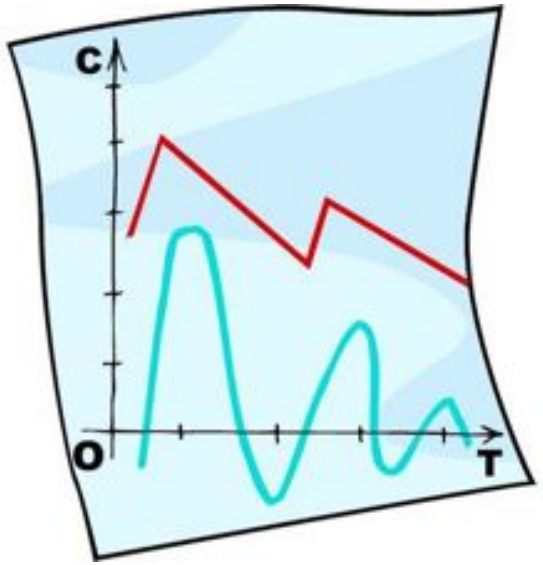
The case study area: Tyne and Wear



Source: based on Tyne and Wear Accessibility Modelling and Edina Digimap

Model and data

- Model
  - $P_i = f(C, T, N)$
    - C is a vector of characteristics of properties
    - T is a vector of transport accessibility
    - N is a vector of the neighbourhood environment
- Data
  - House prices
    - Asking prices not transactional prices
    - Collected at six digit postcode level
    - Included internal features
  - Transport accessibility
  - Socio-economic data



Source: thewordguy.files.wordpress.com/2009/07/data.jpg

Model specification

- $\ln P_i = \alpha_0$
  $+ \alpha_1 BEDROOM_i$
  $+ \alpha_2 FLAT*BED_i + \alpha_3 SEMI*BED_i + \alpha_4 DETA*BED_i$
  $+ \alpha_5 SP\_AVE_i + \alpha_6 \%ETHNM_i + \alpha_7 \%HPROF_i + \alpha_8 \%UNEM_i$
  $+ \alpha_9 CAR\_ACC_i + \alpha_{10} PT\_ACC_i$

Where:

FLAT , SEMI (semi-detached), DETA (detached) are types of property

SP_AVE is the point score for the local primary school

%ETHNM is the % ethnic minority, %HPROF is the % higher professionals and %UNEM is the % unemployed

CAR_ACC is accessibility by car and PT_ACC is accessibility by public transport , measured in minutes

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Global Regression results

Parameter	Estimate	Significance (p-value)
Intercept	11.965	0.000
No. of bedrooms	-0.074	0.000
Flat*bedrooms	0.070	0.000
Semi-detached*bedrooms	0.082	0.000
Detached*bedrooms	0.092	0.000
Average point score of primary school	-0.009	0.085
% ethnic minority	0.001	0.685
% higher professional	0.029	0.000
% unemployment	-0.074	0.000
Car accessibility (mins)	0.021	0.000
PT accessibility (mins)	-0.012	0.003

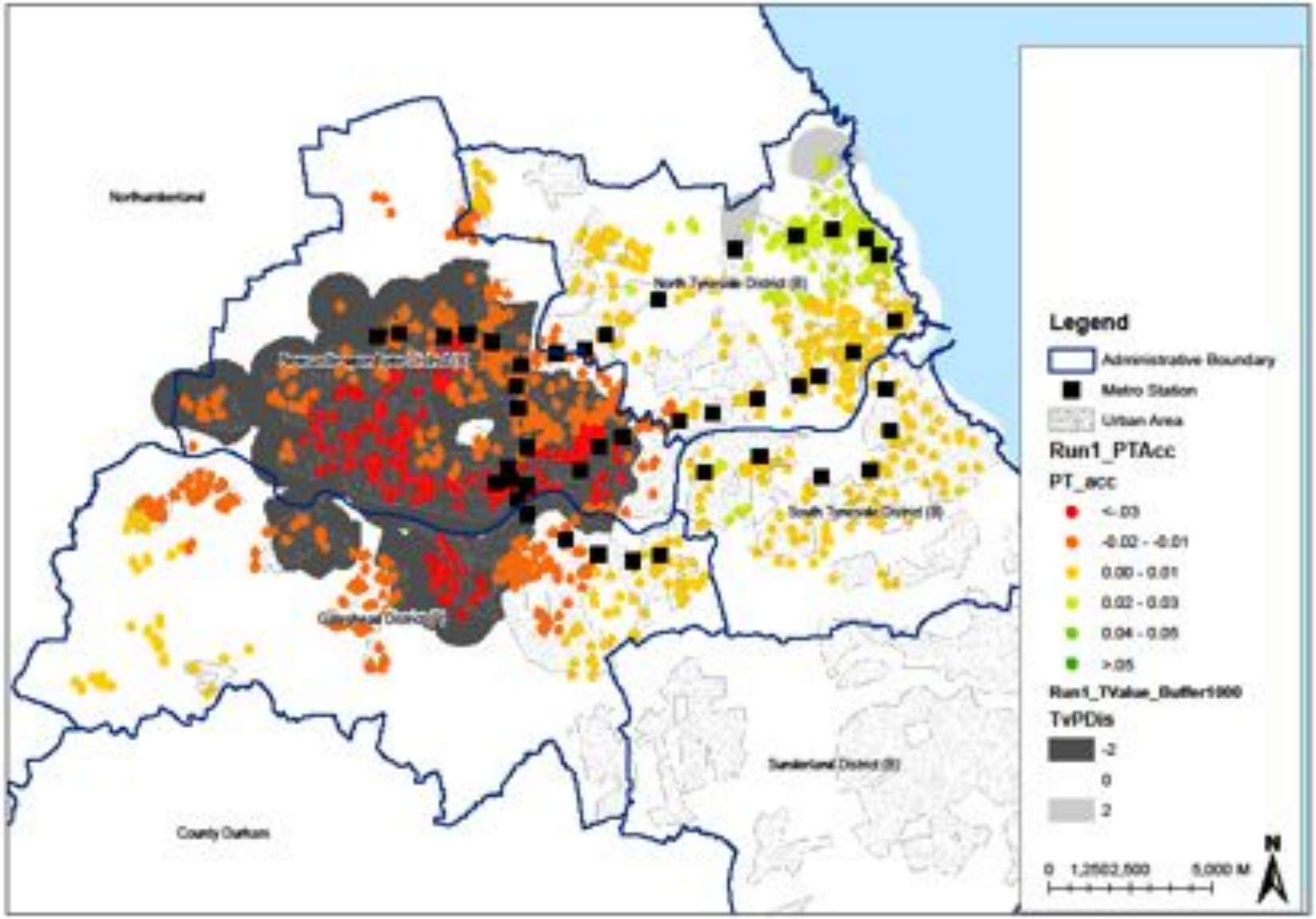
Local Model results

› Is it better than the global results?

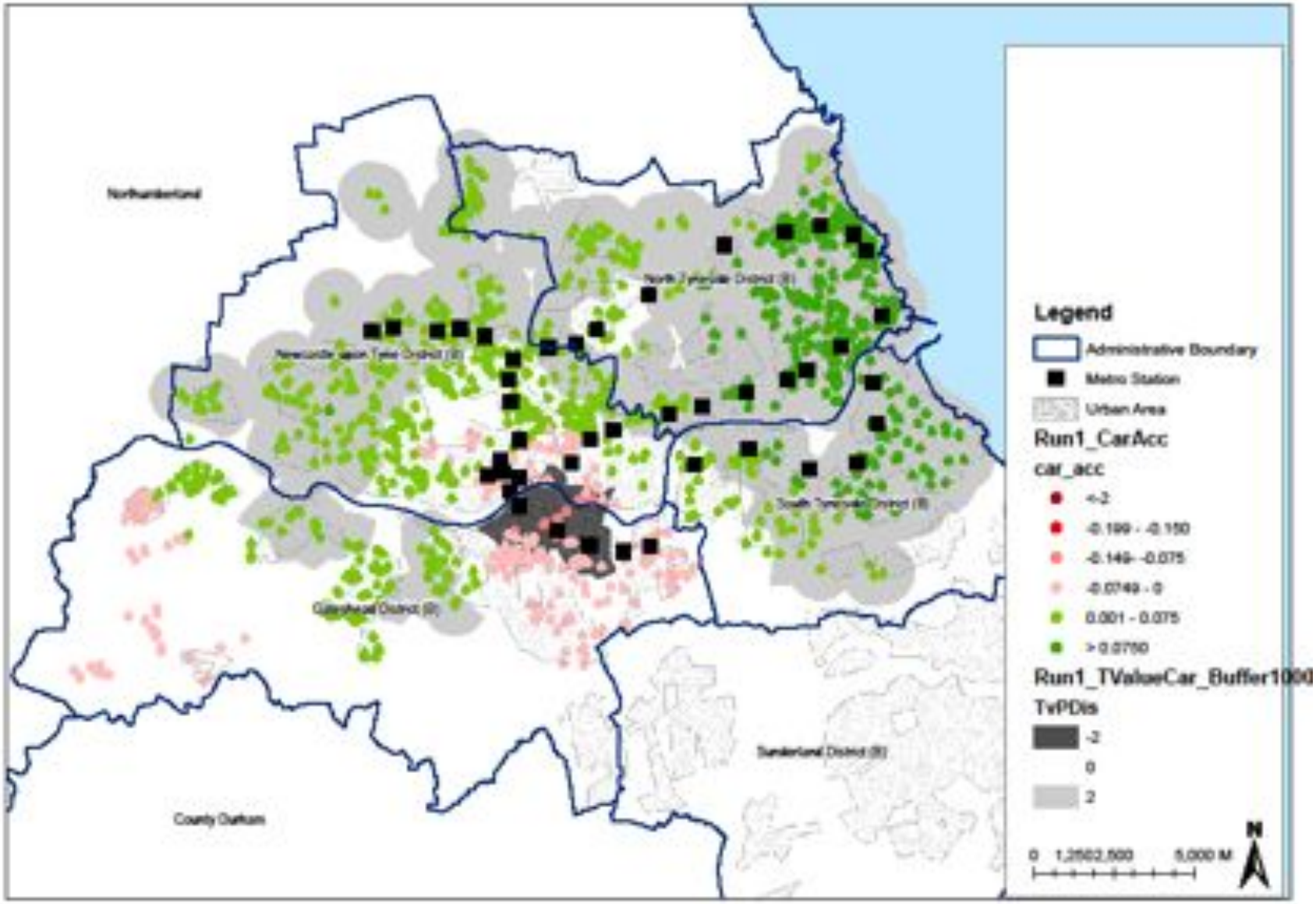
- AIC measure and Monte Carlo test

Parameter	Significance level for spatial variability (p-value)	Significance level in global regression (p-value)
Intercept	0.000	0.000
No. of bedrooms	0.000	0.000
Flat*bedrooms	0.000	0.000
Semi-detached*bedrooms	0.000	0.000
Detached*bedrooms	0.000	0.000
Average point score of primary school	0.040	0.085
% ethnic minority	0.100	0.685
% higher professional	0.000	0.000
% unemployment	0.017	0.000
Car accessibility (mins)	0.000	0.000
PT accessibility (mins)	0.000	0.003

Local model results: public transport accessibility



Local model results: car accessibility



Conclusions

- Methodological contribution of GWR to explaining impact of accessibility on land value
- Empirical results for Tyne and Wear
  - Distributional impacts
- Policy
  - Implications for land value capture policy as a means of funding new transport infrastructure

Source: free foto.com