Mapping welfare estimates from discrete choice experiments

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Choice Modelling Workshop
1–2 May, 2008
Brisbane, Australia

This presentation details the work and analysis presented in:

Campbell D., Hutchinson W.G., Scarpa R. (forthcoming) Using choice experiments to explore the spatial distribution of willingness to pay for rural landscape improvements. *Environment and Planning A*.

Presentation outline

Policy framework

- Agri-environmental schemes have become an important component within the European Union's Common Agricultural Policy.
- Within this context, the Rural Environment Protection (REP) Scheme was introduced in the Republic of Ireland in 1994.
  - The Scheme provides incentives for farmers to maintain and improve the rural environment.

Aims and motivation

- Use choice experiments to elicit WTP for the landscape benefits resulting from the REP Scheme.
- Use geostatistical methods to extend across the whole of the study area the WTP estimates derived from the collected data.
- Highlight any inherently spatial patterns.

Why examine the spatial distribution of WTP?

- Aggregate measures of WTP can obscure local patterns of heterogeneity.
- Spatial analysis provides different insights about WTP—its distribution, regional and local outliers, regional trends, and the degree of spatial dependence.
- While calculating WTP is useful for policy evaluation, it is also useful to know its spatial distribution.
  - Locating areas of value allows more efficient targeting of efforts.

Variations of WTP across space

- Spatial variation in WTP may be a consequence of a number of factors.
  - The socio-demographic distribution of the population is likely to influence the geographic distribution of WTP.
  - Environmental non-market goods themselves are spatially arranged.

Identification of spatial patterns of WTP

- Comparing regional variations in choice models typically requires, either:
  - The estimation of separate models to be estimated for each region.
  - The inclusion of additional location variables in the choice model.
- Both can be adequately used to compare preferences across a relatively small number of regions—but are arguably less suited when the aim is to compare preferences across a relatively large number of regions.

Attributes

- Following a lengthy consultation process with policy experts and members of the general public the following attributes were developed.
  - Mountain Land.
  - Stonewalls.
  - Farmyard Tidiness.
  - Cultural Heritage.
- The cost attribute was described as an increase in the respondent's Income and Value Added Tax.

Farmyard tidiness: No action

Farmyard tidiness: Some action

Farmyard tidiness: A lot of Action

Choice task

	Option A	Option B	No Action
Mountain Land	 A Lot Of Action	 No Action	 No Action
Stonewalls	 A Lot Of Action	 Some Action	 No Action
Farmyard Tidiness	 A Lot Of Action	 Some Action	 No Action
Cultural Heritage	 A Lot of Action	 Some Action	 No Action
Expected Annual Cost	€ 80	€ 20	€ 0

Sampling frame

- To achieve a spatially representative sample, the population was stratified according to five different community types within four standard areas within Ireland.
- Electoral Divisions were chosen within each stratum.
- Six individuals were sampled within each of the pre-selected Electoral Divisions.

Random parameters logit model

- Random parameters logit models provide a flexible and computationally practical econometric method.
- Such models also accommodate the estimation of individual-specific preferences by deriving the conditional distribution (within sample) on the choices (x_n and y_n) made by the each respondent, n.

Random parameters logit model (con'd)

- With knowledge of these parameters, individual-specific WTP estimates can be approximated by simulation as follows:

$$\hat{E}\left[WTP_n\right] = \frac{\frac{1}{R}\sum_{R} -\frac{\hat{\varphi}_n}{\hat{\gamma}_n} L\left(\hat{\beta}_{nr}|y_n,x_n\right)}{\frac{1}{R}\sum_{R} L\left(\hat{\beta}_{nr}|y_n,x_n\right)},$$

where $\hat{\varphi}$ are the landscape attribute parameters, $\hat{\gamma}$ is cost parameter, $\hat{\beta}$ is the vector of parameters, L is the logit probability and R is the number of simulated draws.

Random parameters logit model (con'd)

- To ensure non-negative WTP estimates all attributes are specified as random with constrained triangular distributions.
- The log-likelihood function is estimated with simulated Halton draws.

Kriging

- To elucidate the geographical dimension of WTP, the individual-specific WTP estimates are spatially interpolated.
  - With spatial interpolation, WTP values can be used as a method of benefit transfer by predicting WTP values for all locations in the study area.
- The interpolation method of ordinary Kriging is adopted because our *a priori* expectations of spatially autocorrelated WTP estimates.
  - It is based on the assumption that nearby values contribute more to the interpolated values than distant observations.

Kriging (con'd)

- The general Kriging formula used to interpolate the WTP values is formed as a weighted sum of the data:

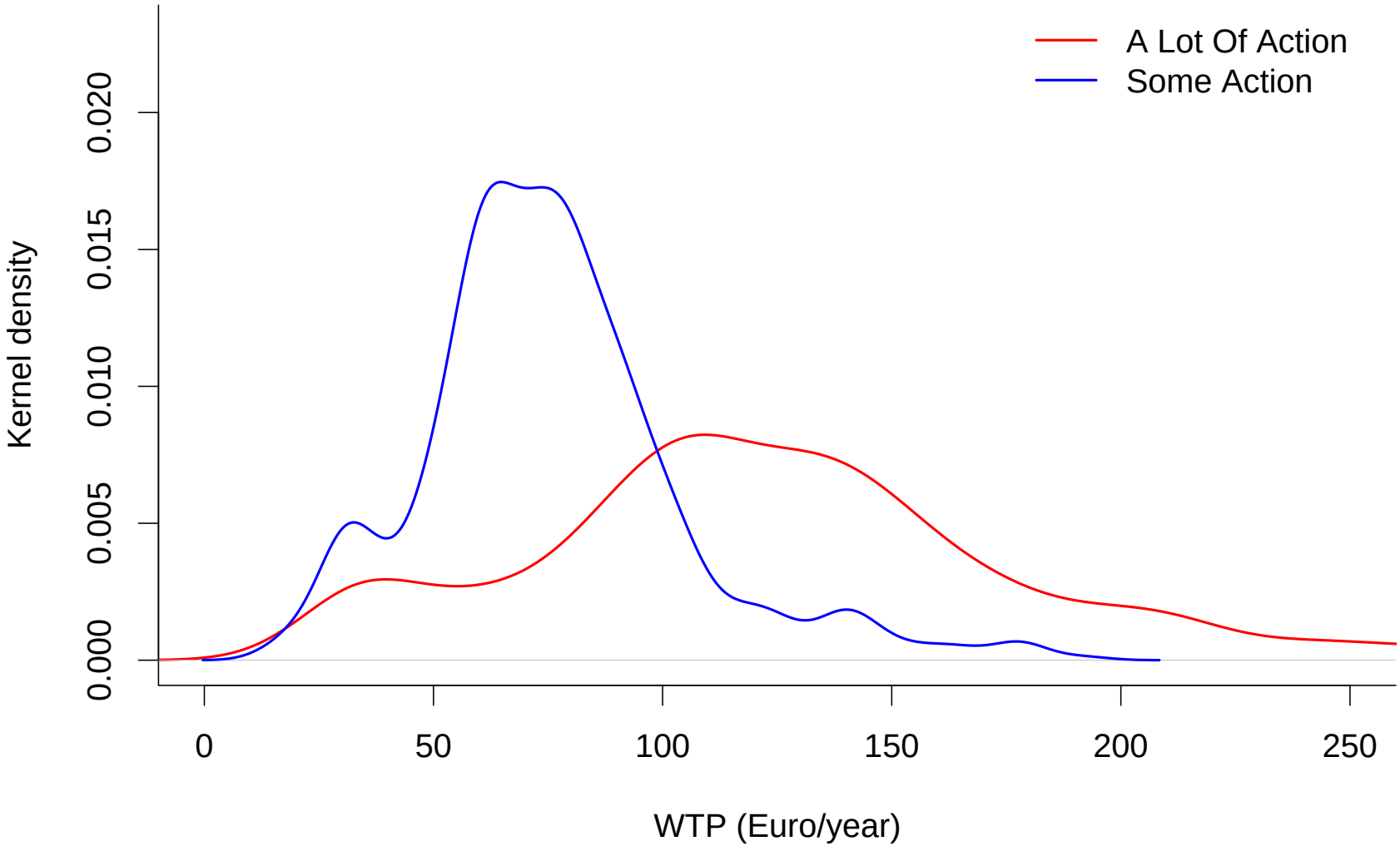
$$\hat{Z}\left[WTP_0\right] = \sum_{i=1}^{n} \omega_i Z\left(WTP_i\right),$$

- where $\hat{Z}\left[WTP_0\right]$ is the predicted WTP estimate at an unsampled location, ω_i is an unknown weight for WTP at the i^{th} location, $Z\left(WTP_i\right)$ is the individual-specific WTP at the i^{th} sample point and n is the number of measured values.

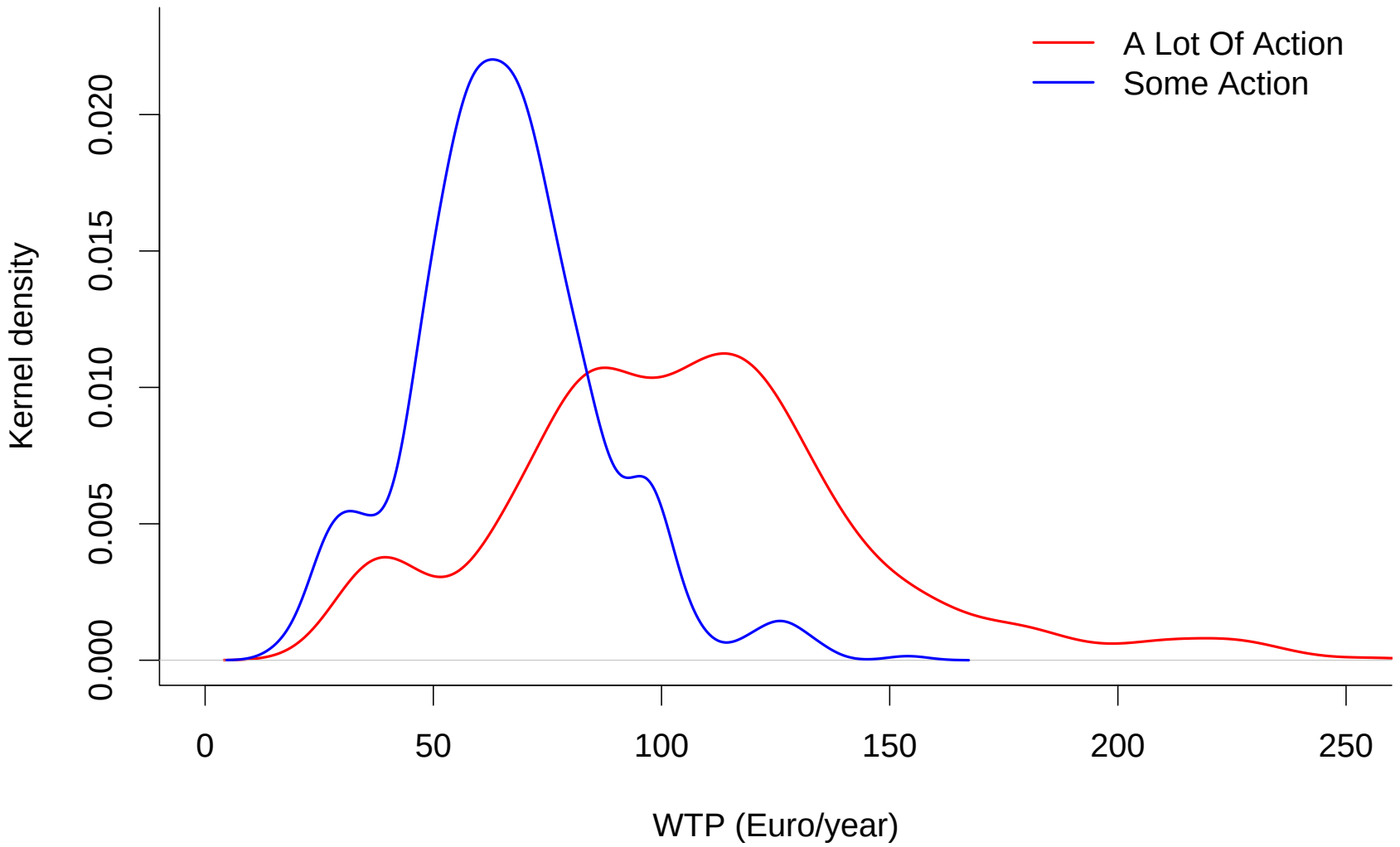
Random parameters logit model

	beta	*t*-ratio
Mountain Land: A Lot Of Action	1.041	12.2
Mountain Land: Some Action	0.598	10.1
Stonewalls: A Lot Of Action	0.870	14.9
Stonewalls: Some Action	0.531	9.5
Farmyard Tidiness: A Lot Of Action	0.794	14.1
Farmyard Tidiness: Some Action	0.502	9.2
Cultural Heritage: A Lot Of Action	0.587	10.2
Cultural Heritage: Some Action	0.577	9.9
Cost	-0.012	-10.6
$\mathcal{L}$		3,775
ρ^2		0.201

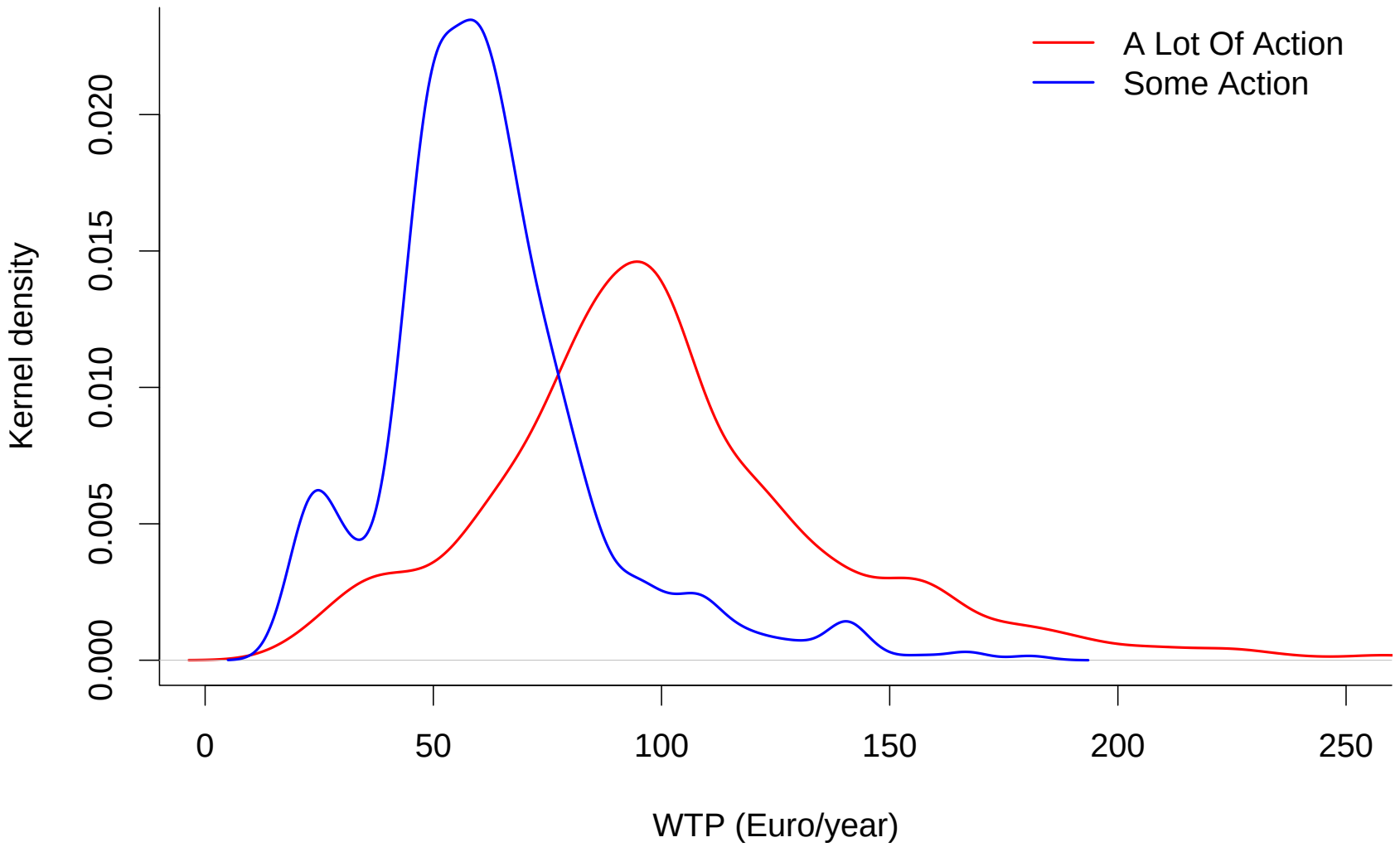
Individual-specific WTP: Mountain Land



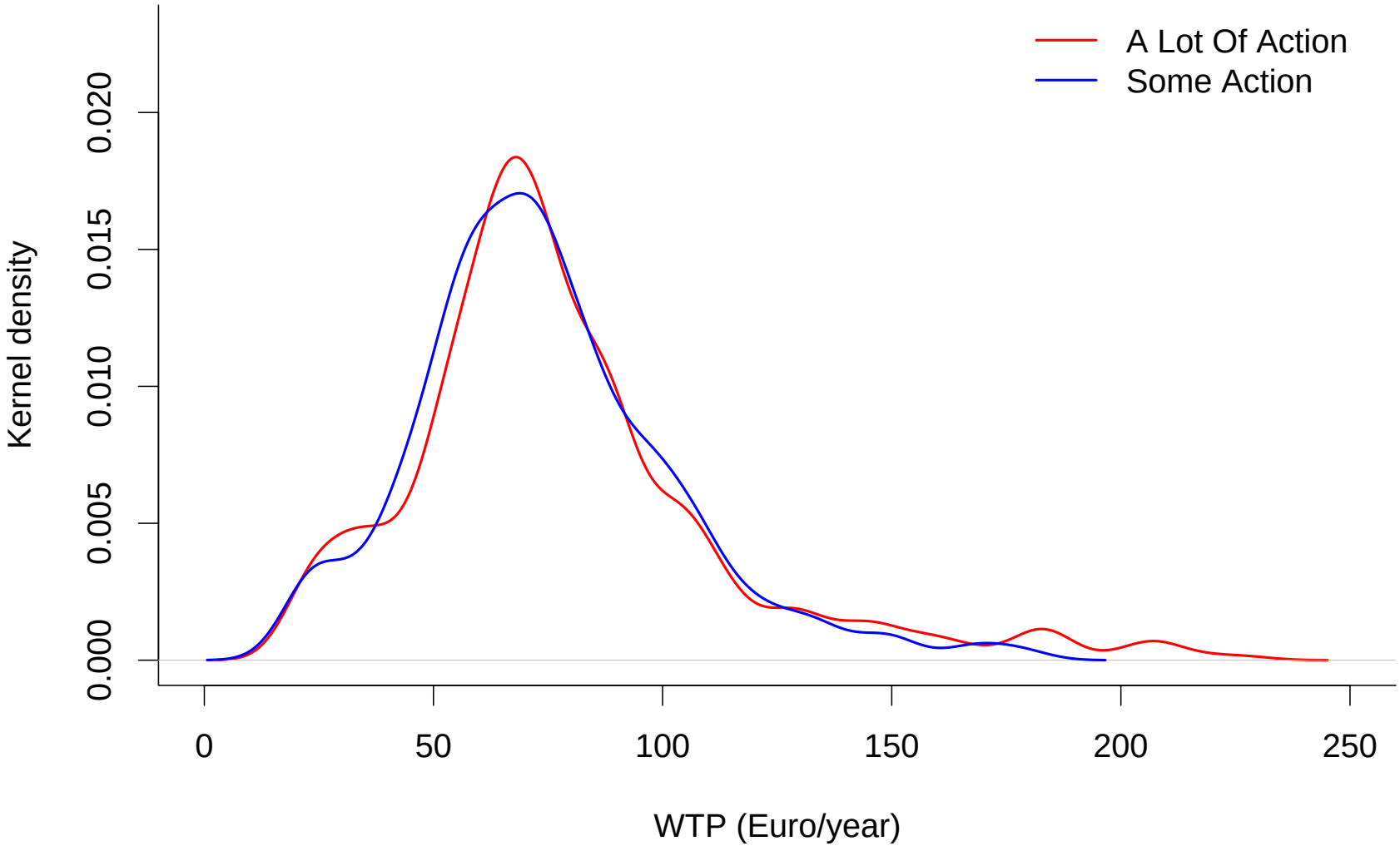
Individual-specific WTP: Stonewalls



Individual-specific WTP: Farmyard Tidiness



Individual-specific WTP: Cultural Heritage



WTP across EDs

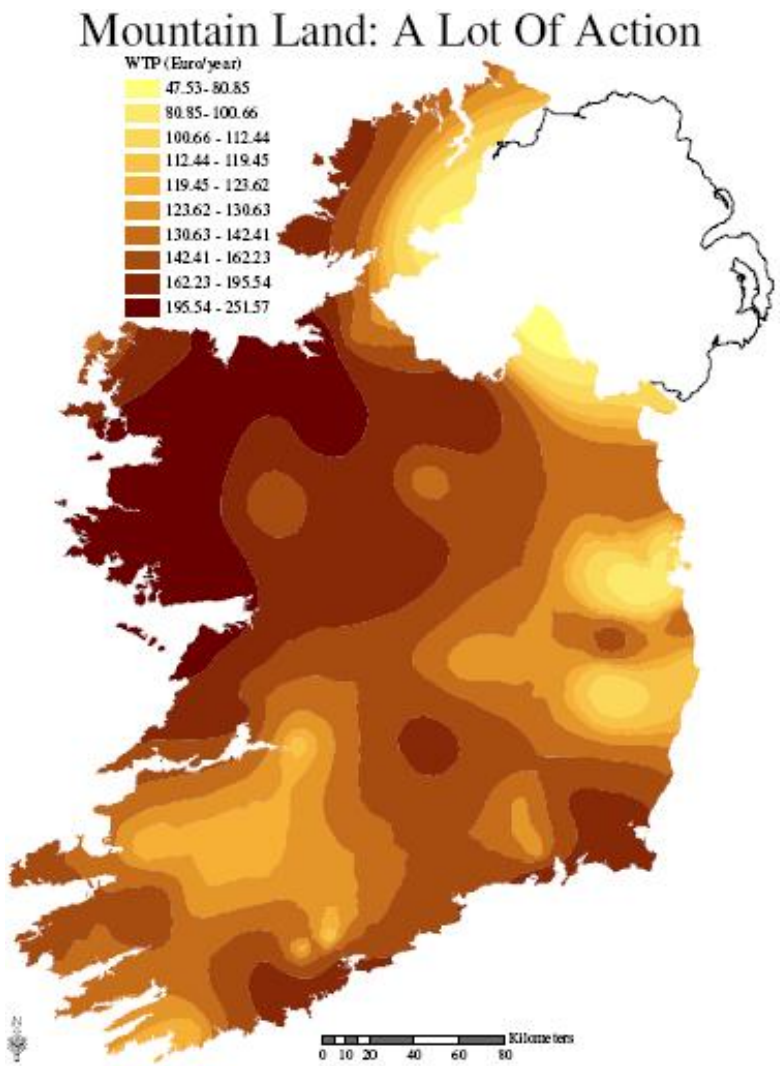
	Mean (€)	Standard deviation (€)	Coefficient of variation (%)
Mountain Land: A Lot Of Action	135	42	31
Mountain Land: Some Action	76	14	19
Stonewalls: A Lot Of Action	104	23	22
Stonewalls: Some Action	65	11	17
Farmyard Tidiness: A Lot Of Action	99	21	22
Farmyard Tidiness: Some Action	61	13	21
Cultural Heritage: A Lot Of Action	78	21	26
Cultural Heritage: Some Action	73	15	21

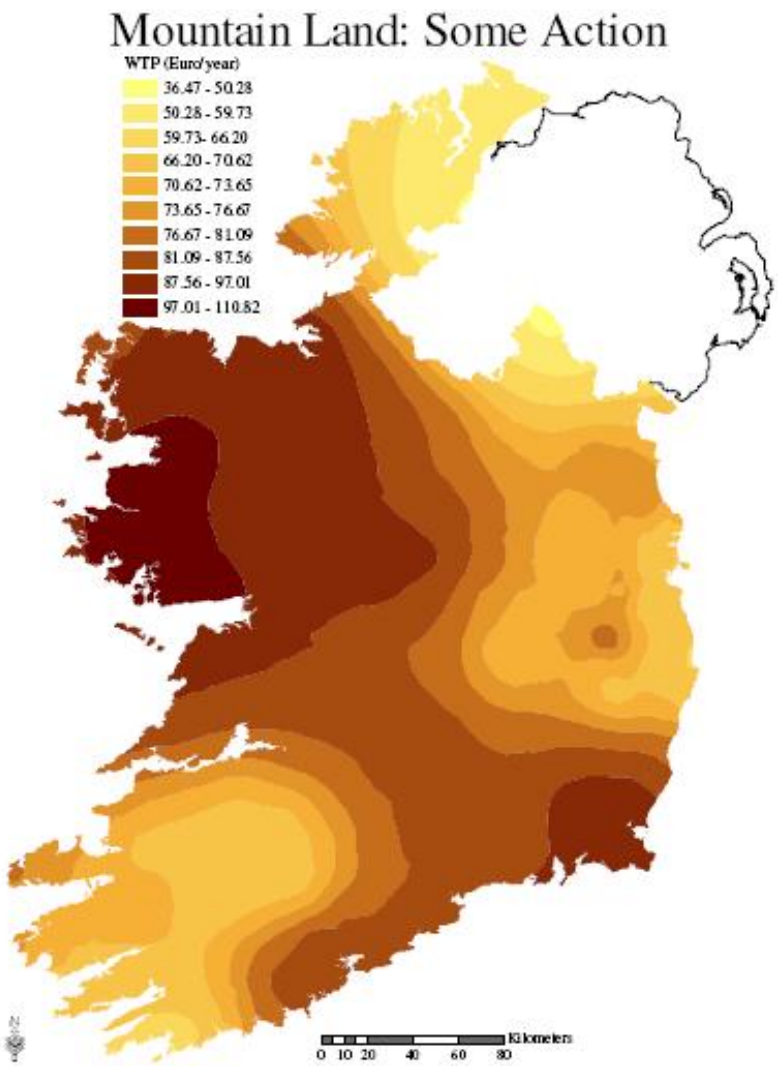
Spatial autocorrelation

	Moran's I[1]	z
Mountain Land: A Lot Of Action	0.512	9.4
Mountain Land: Some Action	0.384	6.9
Stonewalls: A Lot Of Action	0.414	7.6
Stonewalls: Some Action	0.241	4.5
Farmyard Tidiness: A Lot Of Action	0.322	5.8
Farmyard Tidiness: Some Action	0.426	7.8
Cultural Heritage: A Lot Of Action	0.522	10.1
Cultural Heritage: Some Action	0.427	7.7

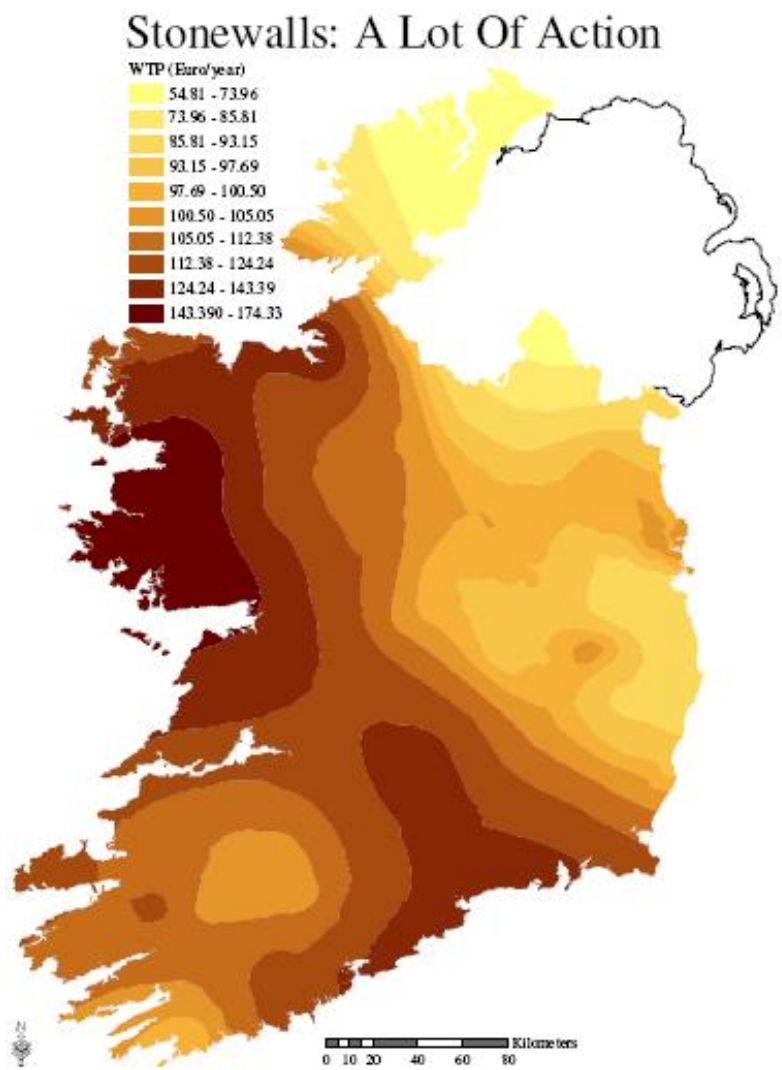
[1] Moran's I is a spatial statistic used to determine spatial autocorrelation.

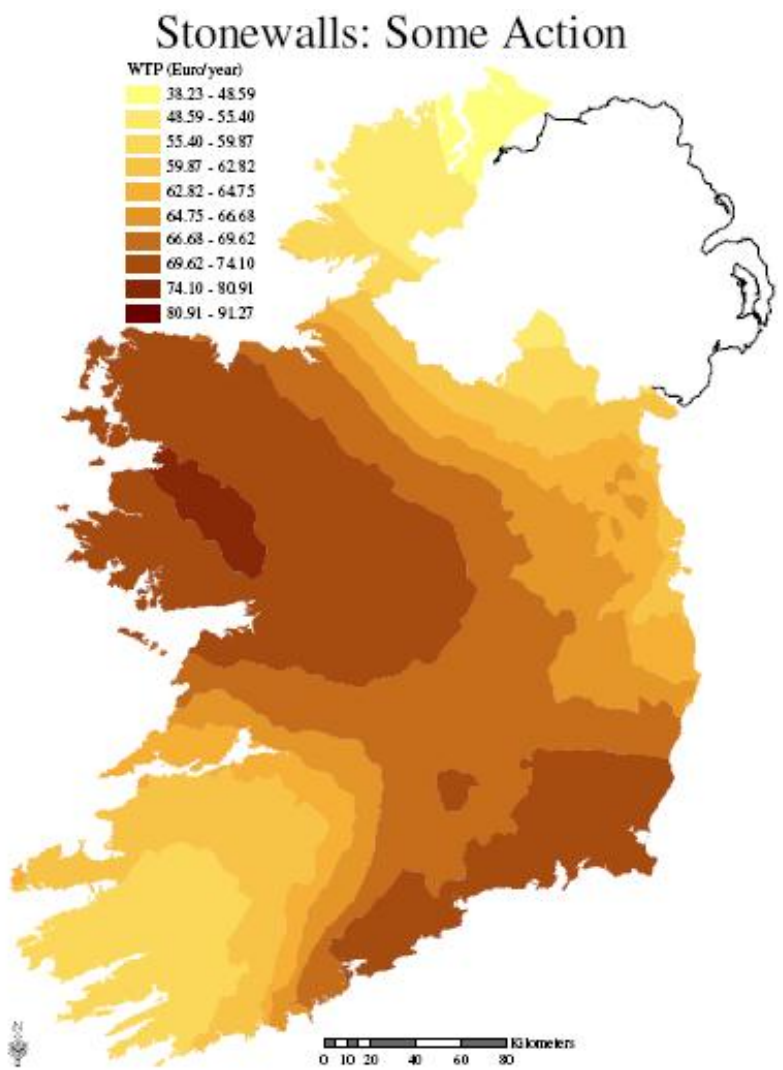
Spatial distribution of WTP: Mountain Land



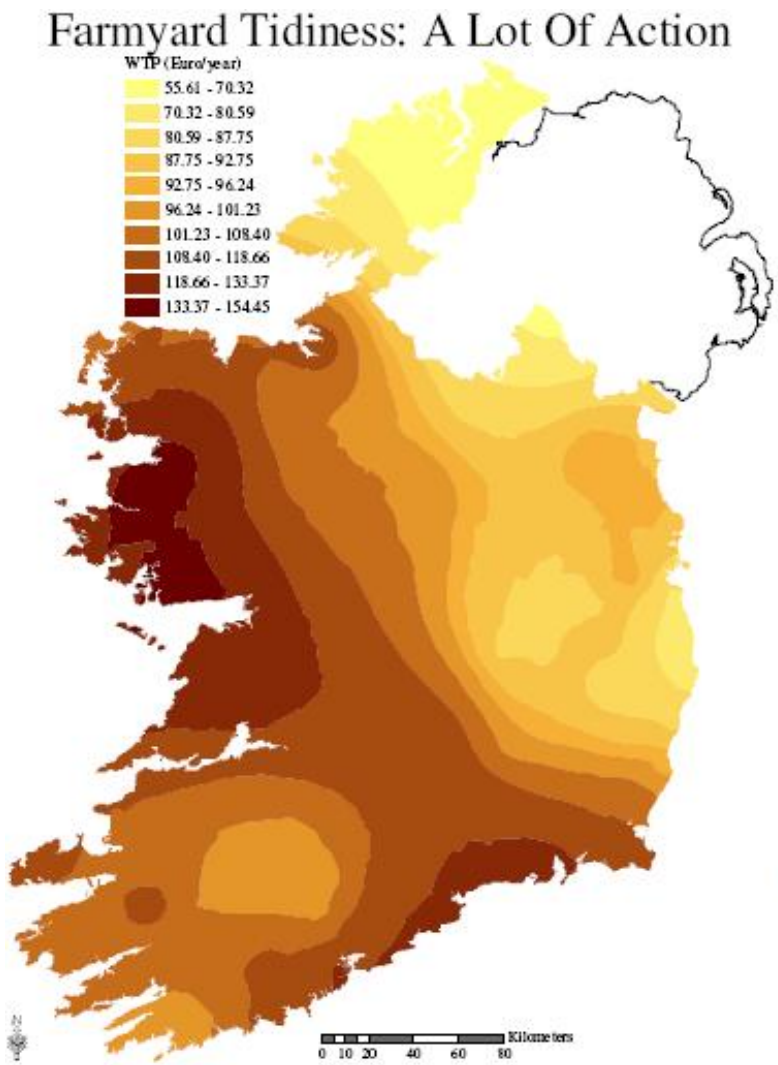


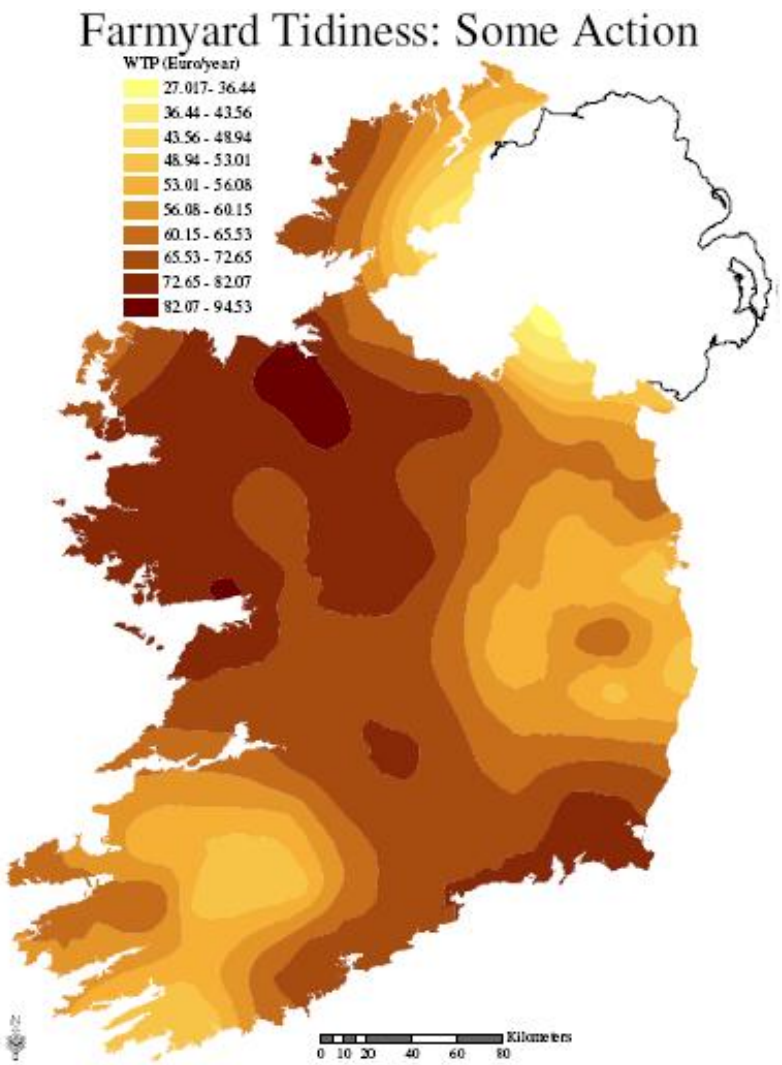
Spatial distribution of WTP: Stonewalls



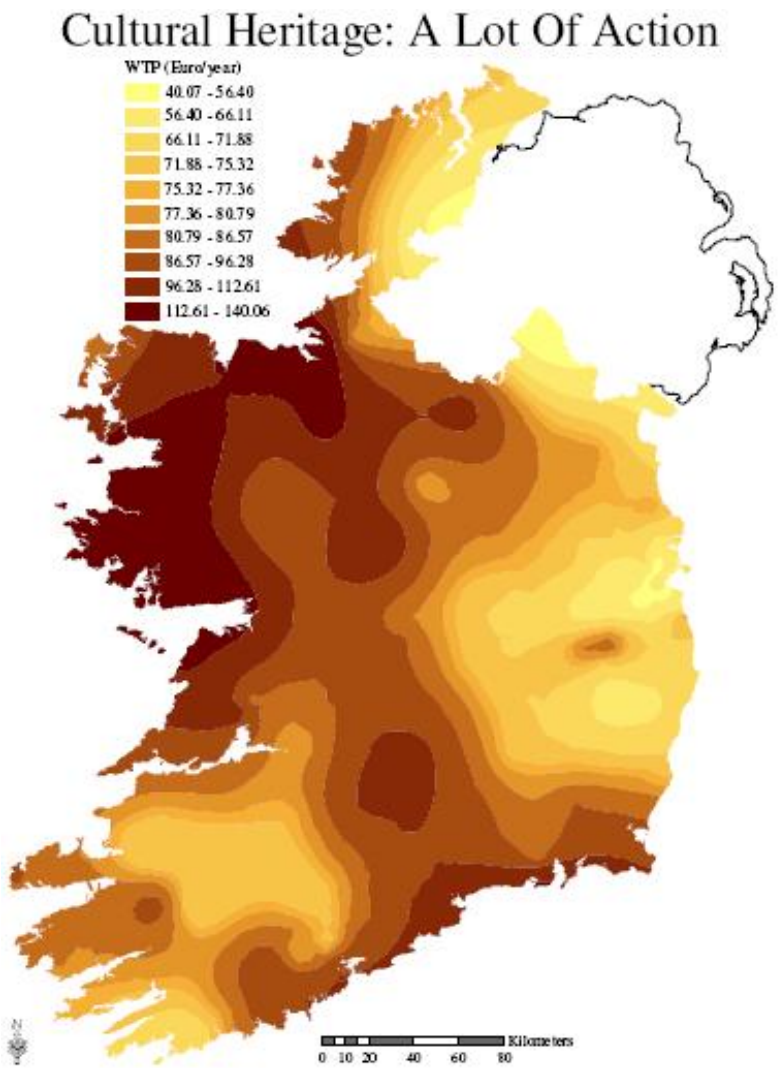


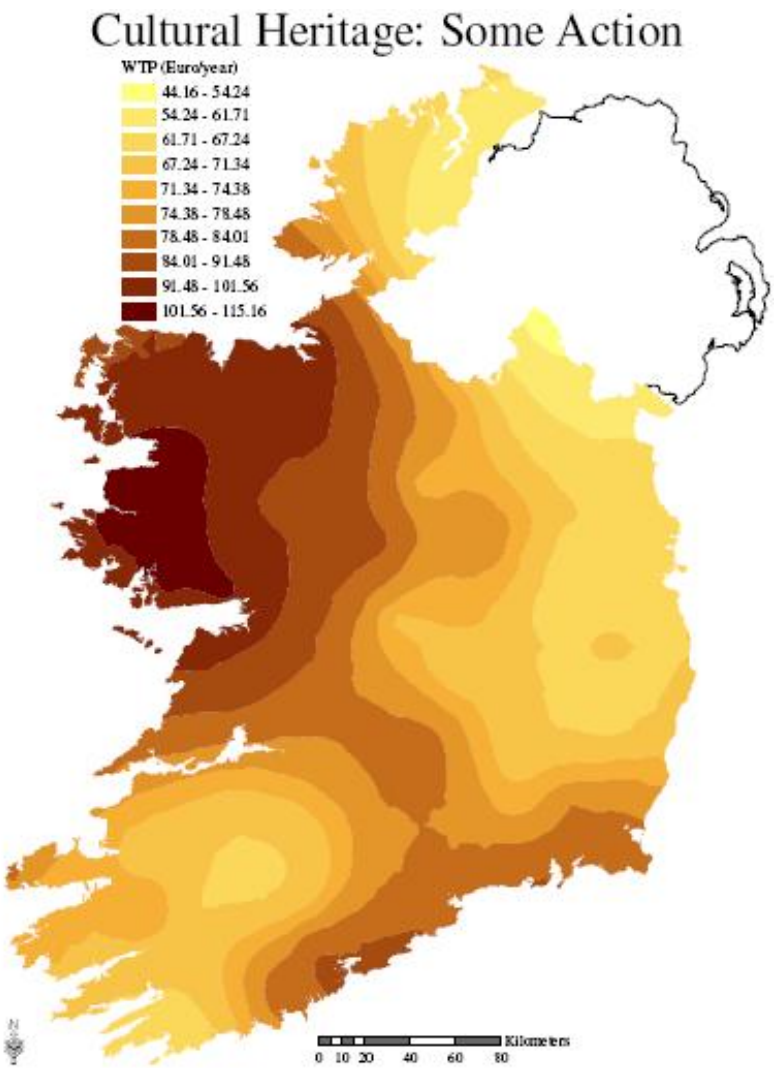
Spatial distribution of WTP: Farmyard Tidiness





Spatial distribution of WTP: Cultural Heritage





Validation results for ordinary Kriging

Attribute	Mean error	Mean error (standardised)
Mountain Land: A Lot Of Action	0.915	0.004
Mountain Land: Some Action	0.508	0.028
Stonewalls: A Lot Of Action	0.713	0.019
Stonewalls: Some Action	0.269	0.023
Farmyard Tidiness: A Lot Of Action	0.682	0.028
Farmyard Tidiness: Some Action	0.443	0.022
Cultural Heritage: A Lot Of Action	0.560	0.008
Cultural Heritage: Some Action	0.357	0.016

Conclusions

- Mapping WTP estimates derived from discrete choice experiments is a valuable tool and adds considerably more explanatory power to the computed welfare estimates.
- Results indicate evidence of spatial dependence, thus indicating spatially dynamic intensities of tastes for the different rural landscape attributes.
- The results also have important policy implications.

Questions . . .