

What are the determinants of brownfields regeneration?

An analysis of brownfields in England

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Presentation Overview

The problem of brownfields

Previous studies

Brownfields in England

The National Land Use Database

The model

Results

Conclusions

Brownfields

US: “abandoned, idled or underused industrial and commercial properties where real or perceived contamination complicates expansion or redevelopment” (Symons, 1998)

UK: “**previously developed land**” (Planning Policy Guidance note 3 – Housing (PPG3))

UK: “land and buildings where reuse may in some way be constrained by physical or regulatory issues that affect its potential for reuse. This includes land and buildings that are derelict and/or vacant and those that are occupied, in whole or part, but which have been identified as having redevelopment potential, though impacted by physical and/or regulatory constraints that hinder or prevent their reuse” (English Partnerships, 2006)

The Reuse of Brownfields

Limit conversion of agricultural land and rural sites to urban uses

Limit urban sprawl

Biodiversity conservation and decrease energy consumption

Promotes economic growth in inner cities

Make cities less congested

Make cities safer places to live

Increase the supply of housing close to local amenities and open space

Cleanup contaminated sites

Reuse of Brownfields in England (1)

England most densely populated country in Europe

Low population density of English cities

Large quantity of under-utilized land within urban areas

Population growth requires 2M new dwellings by 2020

Reuse of Brownfields in England (2)

Reduce greenhouse gases emissions to tackle climate change

Speed up the planning process

Increase access to land and provide more affordable housing

Attract private sector investment and unlock land for housing development

Build social cohesion and minimize anti-social behaviour

At least 60 per cent of new homes in England are to be built on previously developed land by 2008

=> target has been reached

Research Questions

What (local) characteristics make a brownfield more likely to be regenerated?

Has brownfields regeneration mostly occurred in city centres, contributing therefore to limit urban sprawl?

Should size and location specific policies be suggested to better tackle brownfields reuse?

Previous literature

Several studies in the US look at barriers and drivers of brownfields regeneration (Wernstedt, 2004; Wernstedt et al, 2006a, 2006b; Meyer and Lyons, 2000; DeSousa, 2003, 2004; Schoenbaum, 2002; Greenberg et al, 2001; Bartsch and Collaton, 1997; Dennison, 1998; Eisen, 1999)

UK

English Partnerships, 2003, 2006, 2007; BURA, 2006, Syms, 2004; Roberts and Sykes, 2000; Urban Task Force, 1999, 2005; Diamond and Little, 2005; Dair and Williams, 2006; Harrison and Davies, 2002; Dixon et al, 2006; Bardos et al, 2000; Dixon and Doak, 2005; Adams, 2004; Cozens et al, 1999

In-depth case studies

Quantitative analyses are less common (Dixon et al, 2006; Adams et al, 2001)

Novelty of this study

First study to analyse with **quantitative** methods **past decisions** at brownfields

The Data: The National Land Use Database (NLUD)

- (i) Previously developed land which is now vacant;
- (ii) Vacant buildings;
- (iii) Derelict land and buildings;
- (iv) Land or buildings currently in use and allocated in the local plan and/or having planning permission;
- (v) Land or buildings currently in use where it is known there is potential for redevelopment (but the sites do not have any plan allocation or planning permission)

Data are geo-referenced

No information on contamination needs to be recorded

The Model: The Determinants of Brownfields Regeneration

A site will be in use (*in_use*) if the net benefit to the owner is greater than the utility derived from the site if it was unused (*unused*). The owner will choose to regenerate a site if:

$$U_{in_use} > U_{unused}$$

where U represents utility.

The utility function for *in_use* can be expressed with a random utility model:

$$U_{in_use} = \alpha_{in_use} + \beta' \mathbf{x}_{in_use} + \varepsilon_{in_use}$$

\mathbf{x} is a vector of parameters for the site and neighbourhood characteristics

ε is stochastic and is an unobservable factor of utility—and is treated as a random component

The Model (cont.)

The probability that a site will be in use is

$$P_{in_use} = \text{Prob}(U_{in_use} > U_{unused} \quad \forall in_use \neq unused)$$

$$P_{in_use} = \text{Prob}(\alpha_{in_use} + \boldsymbol{\beta}'\mathbf{x}_{in_use} + \varepsilon_{in_use} > \boldsymbol{\beta}'\mathbf{x}_{unused} + \varepsilon_{unused} \quad \forall in_use \neq unused)$$

Assuming the cumulative probability in the above equation has a multivariate normal density leads to the **probit model**.

Implicit in this straightforward probit specification is the assumptions of **homogeneity among sites**.

Heterogeneity among sites located in different Local Authorities

1. Random effects probit model

$$U_{in_use,l} = \alpha_{in_use} + \boldsymbol{\beta}' \mathbf{x}_{in_use,l} + u_{in_use,l}$$

2. Random parameters probit model

3. Latent class probit model

$$U_{in_use} = \alpha_{in_use} + \boldsymbol{\beta}' \mathbf{x}_{in_use} + \left[\boldsymbol{\eta}_{in_use} + \varepsilon_{in_use} \right]$$

DESCRIPTIVE STATISTICS (N=21,808)

Variable	Acronym	mean	s.d.
Site is in use, has been regenerated (dummy)	IN_USE	0.4091	0.4916
Previous activity at the site was housing (dummy)	EX_HOU	0.1809	0.3849
Previous activity at the site was commercial (dummy)	EX_COM	0.2002	0.4001
Previous activity at the site was industrial (dummy)	EX_IND	0.2684	0.4431
Previous activity at the site was agricultural (dummy)	EX_AGRIC	0.0085	0.0917
Previous activity at the site was recreational area (dummy)	EX_REC	0.0093	0.0958
Previous activity at the site was derelict (dummy)	EX_DER	0.0260	0.1590
Previous activity at the site was unused (dummy)	EX_UNUSE	0.0070	0.0832
Previous activity at the site was vacant building (dummy)	EX_VAC_B	0.0226	0.1486
Previous activity at the site was vacant land (dummy)	EX_VAC_L	0.0718	0.2581
Previous activity at the site was unknown (dummy)	EX_DK	0.2054	0.4040
Site area is smaller than the median site area (0.43 hectares) (dummy)	SMALL	0.5018	0.500
Site area is between 0.43 and 1.21 hectares (dummy)	MEDIUM	0.2491	0.2491
Site area is larger than 1.21 hectares (dummy)	LARGE	0.2491	0.2491
Housing suitability (dummy)	HOUSE_SU	0.6545	0.4755
Privately owned (dummy)	PRIVATE	0.6099	0.4877
Site is located in a city (dummy)	CITY	0.2915	0.4544
Site is located in a metropolis (dummy)	METROPOL	0.2566	0.4367
Site is located in a rural area (dummy)	RURAL	0.4519	0.4976
Site is within 0.871km from CBD (dummy)	DIST_50	0.5000	0.500
Site is between 0.871km and 1.85656km from the CBD (dummy)	DIST_75	0.2500	0.4330
Site is beyond 1.85656km from CBD (dummy)	DIST_100	0.2500	0.4330
East Midlands (dummy)	EASTMIDL	0.0962	0.2949
East of England (dummy)	EASTENGL	0.0824	0.2749
London (dummy)	LONDON	0.0542	0.2265
North East (dummy)	NE	0.0675	0.2508
North West (dummy)	NW	0.2169	0.4121
South East (dummy)	SE	0.1323	0.3388
South West (dummy)	SW	0.1042	0.3055
West Midlands (dummy)	WESTMIDL	0.1329	0.3394
Yorkshire and Humberside (dummy)	YORK_HUM	0.1134	0.317

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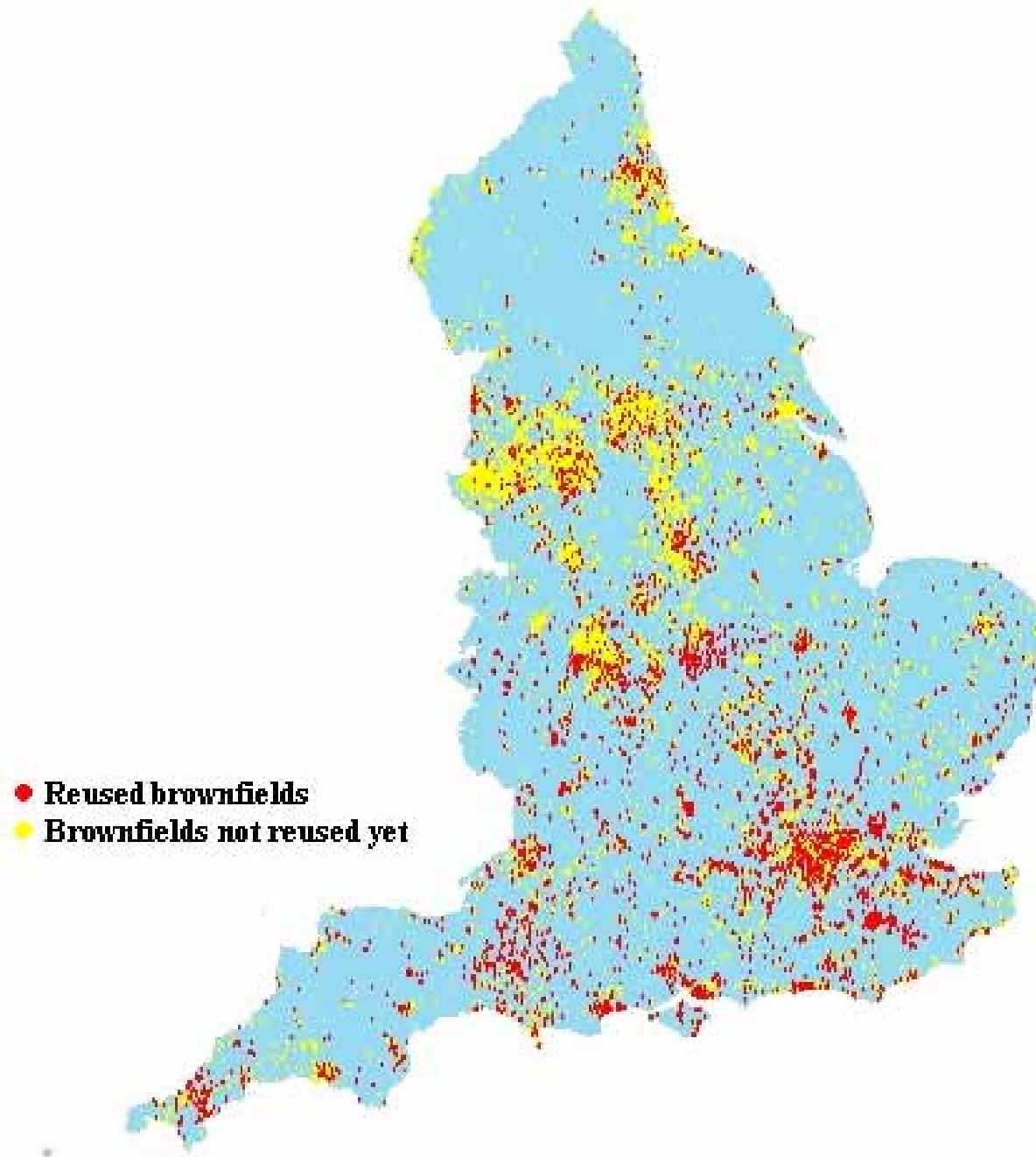
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DESCRIPTIVE STATISTICS (N=21,808)

Variable	Acronym	mean	median	s.d.	max	min
AREA (hectares)		2.1	0.43	11.35	682.6	0.002
Population density. Persons per hectare in Ward in 2001	POP_DENS	24.47	24.47	21.99	236.05	0.04
Index of Multiple Deprivation score for super output areas for year 2004 where sites are located. ^a	IMD_SCOR	29.7	24.57	19.95	86.36	1.16
Distance to the Central Business District (CBD) in Km		1.644	0.871	2.158	27.535	0.007

A Graphical View of Brownfields in England



Variable	Probit model		Random Effects Probit Model		Random Coefficients Probit Model			
	Coefficient	t-statistic	Coefficient	t-statistic	Means		Scale	
					Coefficient	t-statistic	Coefficient	t-statistic
Constant	3.2286	29.6340	3.5701	19.0740	4.0110	32.2730	0.7084	31.2680
EX_HOU	-2.8981	-35.1630	-3.5898	-69.0630	-3.8656	-55.5440	0.6057	14.8510
EX_COM	-3.5138	-43.0090	-4.1478	-80.0850	-4.4296	-71.7030	0.1918	5.6670
EX_IND	-3.6877	-45.7980	-4.3756	-82.6240	-4.5949	-76.3040	0.1125	4.0070
EX_AGRIC	-2.9731	-23.9290	-3.6714	-55.2640	-3.5522	-29.1100	1.2078	6.1440
EX_REC	-3.0839	-24.4910	-3.9175	-26.6750	-4.2885	-24.9660	0.6521	3.4590
EX_DER	-4.9150	-32.5960	-5.4949	-38.0470	-6.2913	-22.2230	1.1574	4.7410
EX_VAC_B	-4.4027	-33.9130	-4.8808	-45.1240	-5.3451	-40.8390	0.9450	7.0030
EX_VAC_L	-4.6801	-46.6620	-5.2523	-84.6570	-5.7031	-51.4480	1.1565	13.5590
EX_UNUSE	-2.1514	-14.7050	-2.9444	-20.9360	-3.0457	-19.7490	0.3933	2.7420
SMALL	0.1723	4.9740	0.1902	5.3390	0.1725	4.0460	0.3213	11.5010
MEDIUM	0.0026	0.0690	-0.0106	-0.2510	-0.0011	-0.0240	0.1627	4.6340
HOUSE_SU	0.3919	13.2560	0.3522	14.1680	0.3540	9.8460	0.6213	25.5620
PRIVATE	0.3336	12.4810	0.3555	16.4340	0.2601	8.8100	0.4146	18.4260
CITY	0.0422	1.1690	0.1119	2.4820	0.0657	1.3530	0.1684	5.4430
METROPOL	0.3421	6.8380	0.0714	0.8580	0.0228	0.2850	0.1908	4.0500
POP_DENS	0.0010	1.2730	0.0010	0.8340	0.0020	1.5590	0.0030	5.0280
IMD_SCOR	-0.0166	-18.3990	-0.0080	-7.5940	-0.0067	-5.6130	0.0080	11.9660
DIST_50	0.0456	1.2370	-0.0163	-0.4060	0.0041	0.0840	0.1308	4.6390
DIST_75	-0.0980	-2.4220	-0.1252	-2.6880	-0.1200	-2.2750	0.1327	3.0580
EASTMIDL	-0.5519	-6.8840	-1.0391	-5.2160	-1.0687	-8.7940	0.5196	8.7610
EASTENGL	-0.4630	-5.7830	-0.6489	-3.1410	-1.3478	-10.9100	0.7570	12.4140
NW	-1.4077	-19.3890	-1.4044	-6.5600	-1.9103	-16.9060	0.3452	7.9740
NE	-0.9361	-11.1380	-1.2465	-4.9790	-1.4645	-10.7270	0.0462	0.5010
SE	-0.0663	-0.8970	0.0065	0.0360	-0.2645	-2.3080	0.6740	16.7220
SW	-0.0945	-1.2200	-0.4252	-2.2510	-0.8684	-7.1780	0.3707	6.0280
WESTMIDL	-0.4379	-5.9410	-0.3042	-1.6190	-0.5904	-4.8000	0.9922	16.8000
YORK_HUM	-1.2437	-15.8430	-1.3999	-7.3250	-1.2106	-9.3360	0.0418	0.5130
Rho			0.4189	23.0950				
Log likelihood function		-6534.26		-5219.16		-4874.74		
McFadden Pseudo R-squared		0.53		0.20		0.25		
Akaike Information Criterion		0.64		0.51		0.48		
N		20345		20345		20345		

Variable	Probit model		Random Effects Probit Model		Random Coefficients Probit Model			
	Coefficient	t-statistic	Coefficient	t-statistic	Means		Scale	
					Coefficient	t-statistic	Coefficient	t-statistic
Constant	3.2286	29.6340	3.5701	19.0740	4.0110	32.2730	0.7084	31.2680
EX_HOU	-2.8981	-35.1630	-3.5898	-69.0630	-3.8656	-55.5440	0.6057	14.8510
EX_COM	-3.5138	-43.0090	-4.1478	-80.0850	-4.4296	-71.7030	0.1918	5.6670
EX_IND	-3.6877	-45.7980	-4.3756	-82.6240	-4.5949	-76.3040	0.1125	4.0070
EX_AGRIC	-2.9731	-23.9290	-3.6714	-55.2640	-3.5522	-29.1100	1.2078	6.1440
EX_REC	-3.0839	-24.4910	-3.9175	-26.6750	-4.2885	-24.9660	0.6521	3.4590
EX_DER	-4.9150	-32.5960	-5.4949	-38.0470	-6.2913	-22.2230	1.1574	4.7410
EX_VAC_B	-4.4027	-33.9130	-4.8808	-45.1240	-5.3451	-40.8390	0.9450	7.0030
EX_VAC_L	-4.6801	-46.6620	-5.2523	-84.6570	-5.7031	-51.4480	1.1565	13.5590
EX_UNUSE	-2.1514	-14.7050	-2.9444	-20.9360	-3.0457	-19.7490	0.3933	2.7420
SMALL	0.1723	4.9740	0.1902	5.3390	0.1725	4.0460	0.3213	11.5010
MEDIUM	0.0026	0.0690	-0.0106	-0.2510	-0.0011	-0.0240	0.1627	4.6340
HOUSE_SU	0.3919	13.2560	0.3522	14.1680	0.3540	9.8460	0.6213	25.5620
PRIVATE	0.3336	12.4810	0.3555	16.4340	0.2601	8.8100	0.4146	18.4260
CITY	0.0422	1.1690	0.1119	2.4820	0.0657	1.3530	0.1684	5.4430
METROPOL	0.3421	6.8380	0.0714	0.8580	0.0228	0.2850	0.1908	4.0500
POP_DENS	0.0010	1.2730	0.0010	0.8340	0.0020	1.5590	0.0030	5.0280
IMD_SCOR	-0.0166	-18.3990	-0.0080	-7.5940	-0.0067	-5.6130	0.0080	11.9660
DIST_50	0.0456	1.2370	-0.0163	-0.4060	0.0041	0.0840	0.1308	4.6390
DIST_75	-0.0980	-2.4220	-0.1252	-2.6880	-0.1200	-2.2750	0.1327	3.0580
EASTMIDL	-0.5519	-6.8840	-1.0391	-5.2160	-1.0687	-8.7940	0.5196	8.7610
EASTENGL	-0.4630	-5.7830	-0.6489	-3.1410	-1.3478	-10.9100	0.7570	12.4140
NW	-1.4077	-19.3890	-1.4044	-6.5600	-1.9103	-16.9060	0.3452	7.9740
NE	-0.9361	-11.1380	-1.2465	-4.9790	-1.4645	-10.7270	0.0462	0.5010
SE	-0.0663	-0.8970	0.0065	0.0360	-0.2645	-2.3080	0.6740	16.7220
SW	-0.0945	-1.2200	-0.4252	-2.2510	-0.8684	-7.1780	0.3707	6.0280
WESTMIDL	-0.4379	-5.9410	-0.3042	-1.6190	-0.5904	-4.8000	0.9922	16.8000
YORK_HUM	-1.2437	-15.8430	-1.3999	-7.3250	-1.2106	-9.3360	0.0418	0.5130
Rho			0.4189	23.0950				
Log likelihood function		-6534.26		-5219.16		-4874.74		
McFadden Pseudo R-squared		0.53		0.20		0.25		
Akaike Information Criterion		0.64		0.51		0.48		
N		20345		20345		20345		

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EX_HOU	-2.8981	-35.1630	-3.5898	-69.0630	-3.8656	-55.5440	0.6057	14.8510
EX_COM	-3.5138	-43.0090	-4.1478	-80.0850	-4.4296	-71.7030	0.1918	5.6670
EX_IND	-3.6877	-45.7980	-4.3756	-82.6240	-4.5949	-76.3040	0.1125	4.0070
EX_AGRIC	-2.9731	-23.9290	-3.6714	-55.2640	-3.5522	-29.1100	1.2078	6.1440
EX_REC	-3.0839	-24.4910	-3.9175	-26.6750	-4.2885	-24.9660	0.6521	3.4590
EX_DER	-4.9150	-32.5960	-5.4949	-38.0470	-6.2913	-22.2230	1.1574	4.7410
EX_VAC_B	-4.4027	-33.9130	-4.8808	-45.1240	-5.3451	-40.8390	0.9450	7.0030
EX_VAC_L	-4.6801	-46.6620	-5.2523	-84.6570	-5.7031	-51.4480	1.1565	13.5590
EX_UNUSE	-2.1514	-14.7050	-2.9444	-20.9360	-3.0457	-19.7490	0.3933	2.7420
SMALL	0.1723	4.9740	0.1902	5.3390	0.1725	4.0460	0.3213	11.5010
MEDIUM	0.0026	0.0690	-0.0106	-0.2510	-0.0011	-0.0240	0.1627	4.6340
HOUSE_SU	0.3919	13.2560	0.3522	14.1680	0.3540	9.8460	0.6213	25.5620
PRIVATE	0.3336	12.4810	0.3555	16.4340	0.2601	8.8100	0.4146	18.4260
CITY	0.0422	1.1690	0.1119	2.4820	0.0657	1.3530	0.1684	5.4430
METROPOL	0.3421	6.8380	0.0714	0.8580	0.0228	0.2850	0.1908	4.0500
POP_DENS	0.0010	1.2730	0.0010	0.8340	0.0020	1.5590	0.0030	5.0280
IMD_SCOR	-0.0166	-18.3990	-0.0080	-7.5940	-0.0067	-5.6130	0.0080	11.9660
DIST_50	0.0456	1.2370	-0.0163	-0.4060	0.0041	0.0840	0.1308	4.6390
DIST_75	-0.0980	-2.4220	-0.1252	-2.6880	-0.1200	-2.2750	0.1327	3.0580
EASTMIDL	-0.5519	-6.8840	-1.0391	-5.2160	-1.0687	-8.7940	0.5196	8.7610
EASTENGL	-0.4630	-5.7830	-0.6489	-3.1410	-1.3478	-10.9100	0.7570	12.4140
NW	-1.4077	-19.3890	-1.4044	-6.5600	-1.9103	-16.9060	0.3452	7.9740
NE	-0.9361	-11.1380	-1.2465	-4.9790	-1.4645	-10.7270	0.0462	0.5010
SE	-0.0663	-0.8970	0.0065	0.0360	-0.2645	-2.3080	0.6740	16.7220
SW	-0.0945	-1.2200	-0.4252	-2.2510	-0.8684	-7.1780	0.3707	6.0280
WESTMIDL	-0.4379	-5.9410	-0.3042	-1.6190	-0.5904	-4.8000	0.9922	16.8000
YORK_HUM	-1.2437	-15.8430	-1.3999	-7.3250	-1.2106	-9.3360	0.0418	0.5130
Rho			0.4189	23.0950				
Log likelihood function		-6534.26		-5219.16		-4874.74		
McFadden Pseudo R-squared		0.53		0.20		0.25		
Akaike Information Criterion		0.64		0.51		0.48		
N		20345		20345		20345		

Probit model		Random Effects Probit Model			Random Coefficients Probit Model			
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Means		Scale	
					Coefficient	t-statistic	Coefficient	t-statistic
Constant	3.2286	29.6340	3.5701	19.0740	4.0110	32.2730	0.7084	31.2680
EX_HOU	-2.8981	-35.1630	-3.5898	-69.0630	-3.8656	-55.5440	0.6057	14.8510
EX_COM	-3.5138	-43.0090	-4.1478	-80.0850	-4.4296	-71.7030	0.1918	5.6670
EX_IND	-3.6877	-45.7980	-4.3756	-82.6240	-4.5949	-76.3040	0.1125	4.0070
EX_AGRIC	-2.9731	-23.9290	-3.6714	-55.2640	-3.5522	-29.1100	1.2078	6.1440
EX_REC	-3.0839	-24.4910	-3.9175	-26.6750	-4.2885	-24.9660	0.6521	3.4590
EX_DER	-4.9150	-32.5960	-5.4949	-38.0470	-6.2913	-22.2230	1.1574	4.7410
EX_VAC_B	-4.4027	-33.9130	-4.8808	-45.1240	-5.3451	-40.8390	0.9450	7.0030
EX_VAC_L	-4.6801	-46.6620	-5.2523	-84.6570	-5.7031	-51.4480	1.1565	13.5590
EX_UNUSE	-2.1514	-14.7050	-2.9444	-20.9360	-3.0457	-19.7490	0.3933	2.7420
SMALL	0.1723	4.9740	0.1902	5.3390	0.1725	4.0460	0.3213	11.5010
MEDIUM	0.0026	0.0690	-0.0106	-0.2510	-0.0011	-0.0240	0.1627	4.6340
HOUSE_SU	0.3919	13.2560	0.3522	14.1680	0.3540	9.8460	0.6213	25.5620
PRIVATE	0.3336	12.4810	0.3555	16.4340	0.2601	8.8100	0.4146	18.4260
CITY	0.0422	1.1690	0.1119	2.4820	0.0657	1.3530	0.1684	5.4430
METROPOL	0.3421	6.8380	0.0714	0.8580	0.0228	0.2850	0.1908	4.0500
POP_DENS	0.0010	1.2730	0.0010	0.8340	0.0020	1.5590	0.0030	5.0280
IMD_SCOR	-0.0166	-18.3990	-0.0080	-7.5940	-0.0067	-5.6130	0.0080	11.9660
DIST_50	0.0456	1.2370	-0.0163	-0.4060	0.0041	0.0840	0.1308	4.6390
DIST_75	-0.0980	-2.4220	-0.1252	-2.6880	-0.1200	-2.2750	0.1327	3.0580
EASTMIDL	-0.5519	-6.8840	-1.0391	-5.2160	-1.0687	-8.7940	0.5196	8.7610
EASTENGL	-0.4630	-5.7830	-0.6489	-3.1410	-1.3478	-10.9100	0.7570	12.4140
NW	-1.4077	-19.3890	-1.4044	-6.5600	-1.9103	-16.9060	0.3452	7.9740
NE	-0.9361	-11.1380	-1.2465	-4.9790	-1.4645	-10.7270	0.0462	0.5010
SE	-0.0663	-0.8970	0.0065	0.0360	-0.2645	-2.3080	0.6740	16.7220
SW	-0.0945	-1.2200	-0.4252	-2.2510	-0.8684	-7.1780	0.3707	6.0280
WESTMIDL	-0.4379	-5.9410	-0.3042	-1.6190	-0.5904	-4.8000	0.9922	16.8000
YORK_HUM	-1.2437	-15.8430	-1.3999	-7.3250	-1.2106	-9.3360	0.0418	0.5130
Rho			0.4189	23.0950				
Log likelihood function		-6534.26		-5219.16		-4874.74		
McFadden Pseudo R-squared		0.53		0.20		0.25		
Akaike Information Criterion		0.64		0.51		0.48		
N		20345		20345		20345		

Probit model			Random Effects Probit Model		Random Coefficients Probit Model			
Variable					Means		Scale	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Constant	3.2286	29.6340	3.5701	19.0740	4.0110	32.2730	0.7084	31.2680
EX_HOU	-2.8981	-35.1630	-3.5898	-69.0630	-3.8656	-55.5440	0.6057	14.8510
EX_COM	-3.5138	-43.0090	-4.1478	-80.0850	-4.4296	-71.7030	0.1918	5.6670
EX_IND	-3.6877	-45.7980	-4.3756	-82.6240	-4.5949	-76.3040	0.1125	4.0070
EX_AGRIC	-2.9731	-23.9290	-3.6714	-55.2640	-3.5522	-29.1100	1.2078	6.1440
EX_REC	-3.0839	-24.4910	-3.9175	-26.6750	-4.2885	-24.9660	0.6521	3.4590
EX_DER	-4.9150	-32.5960	-5.4949	-38.0470	-6.2913	-22.2230	1.1574	4.7410
EX_VAC_B	-4.4027	-33.9130	-4.8808	-45.1240	-5.3451	-40.8390	0.9450	7.0030
EX_VAC_L	-4.6801	-46.6620	-5.2523	-84.6570	-5.7031	-51.4480	1.1565	13.5590
EX_UNUSE	-2.1514	-14.7050	-2.9444	-20.9360	-3.0457	-19.7490	0.3933	2.7420
SMALL	0.1723	4.9740	0.1902	5.3390	0.1725	4.0460	0.3213	11.5010
MEDIUM	0.0026	0.0690	-0.0106	-0.2510	-0.0011	-0.0240	0.1627	4.6340
HOUSE_SU	0.3919	13.2560	0.3522	14.1680	0.3540	9.8460	0.6213	25.5620
PRIVATE	0.3336	12.4810	0.3555	16.4340	0.2601	8.8100	0.4146	18.4260
CITY	0.0422	1.1690	0.1119	2.4820	0.0657	1.3530	0.1684	5.4430
METROPOL	0.3421	6.8380	0.0714	0.8580	0.0228	0.2850	0.1908	4.0500
POP_DENS	0.0010	1.2730	0.0010	0.8340	0.0020	1.5590	0.0030	5.0280
IMD_SCOR	-0.0166	-18.3990	-0.0080	-7.5940	-0.0067	-5.6130	0.0080	11.9660
DIST_50	0.0456	1.2370	-0.0163	-0.4060	0.0041	0.0840	0.1308	4.6390
DIST_75	-0.0980	-2.4220	-0.1252	-2.6880	-0.1200	-2.2750	0.1327	3.0580
EASTMIDL	-0.5519	-6.8840	-1.0391	-5.2160	-1.0687	-8.7940	0.5196	8.7610
EASTENGL	-0.4630	-5.7830	-0.6489	-3.1410	-1.3478	-10.9100	0.7570	12.4140
NW	-1.4077	-19.3890	-1.4044	-6.5600	-1.9103	-16.9060	0.3452	7.9740
NE	-0.9361	-11.1380	-1.2465	-4.9790	-1.4645	-10.7270	0.0462	0.5010
SE	-0.0663	-0.8970	0.0065	0.0360	-0.2645	-2.3080	0.6740	16.7220
SW	-0.0945	-1.2200	-0.4252	-2.2510	-0.8684	-7.1780	0.3707	6.0280
WESTMIDL	-0.4379	-5.9410	-0.3042	-1.6190	-0.5904	-4.8000	0.9922	16.8000
YORK_HUM	-1.2437	-15.8430	-1.3999	-7.3250	-1.2106	-9.3360	0.0418	0.5130
Rho			0.4189	23.0950				
Log likelihood function		-6534.26		-5219.16		-4874.74		
McFadden Pseudo R-squared		0.53		0.20		0.25		
Akaike Information Criterion		0.64		0.51		0.48		
N		20345		20345		20345		

Probit model			Random Effects Probit Model		Random Coefficients Probit Model			
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Means		Scale	
					Coefficient	t-statistic	Coefficient	t-statistic
Constant	3.2286	29.6340	3.5701	19.0740	4.0110	32.2730	0.7084	31.2680
EX_HOU	-2.8981	-35.1630	-3.5898	-69.0630	-3.8656	-55.5440	0.6057	14.8510
EX_COM	-3.5138	-43.0090	-4.1478	-80.0850	-4.4296	-71.7030	0.1918	5.6670
EX_IND	-3.6877	-45.7980	-4.3756	-82.6240	-4.5949	-76.3040	0.1125	4.0070
EX_AGRIC	-2.9731	-23.9290	-3.6714	-55.2640	-3.5522	-29.1100	1.2078	6.1440
EX_REC	-3.0839	-24.4910	-3.9175	-26.6750	-4.2885	-24.9660	0.6521	3.4590
EX_DER	-4.9150	-32.5960	-5.4949	-38.0470	-6.2913	-22.2230	1.1574	4.7410
EX_VAC_B	-4.4027	-33.9130	-4.8808	-45.1240	-5.3451	-40.8390	0.9450	7.0030
EX_VAC_L	-4.6801	-46.6620	-5.2523	-84.6570	-5.7031	-51.4480	1.1565	13.5590
EX_UNUSE	-2.1514	-14.7050	-2.9444	-20.9360	-3.0457	-19.7490	0.3933	2.7420
SMALL	0.1723	4.9740	0.1902	5.3390	0.1725	4.0460	0.3213	11.5010
MEDIUM	0.0026	0.0690	-0.0106	-0.2510	-0.0011	-0.0240	0.1627	4.6340
HOUSE_SU	0.3919	13.2560	0.3522	14.1680	0.3540	9.8460	0.6213	25.5620
PRIVATE	0.3336	12.4810	0.3555	16.4340	0.2601	8.8100	0.4146	18.4260
CITY	0.0422	1.1690	0.1119	2.4820	0.0657	1.3530	0.1684	5.4430
METROPOL	0.3421	6.8380	0.0714	0.8580	0.0228	0.2850	0.1908	4.0500
POP_DENS	0.0010	1.2730	0.0010	0.8340	0.0020	1.5590	0.0030	5.0280
IMD_SCOR	-0.0166	-18.3990	-0.0080	-7.5940	-0.0067	-5.6130	0.0080	11.9660
DIST_50	0.0456	1.2370	-0.0163	-0.4060	0.0041	0.0840	0.1308	4.6390
DIST_75	-0.0980	-2.4220	-0.1252	-2.6880	-0.1200	-2.2750	0.1327	3.0580
EASTMIDL	-0.5519	-6.8840	-1.0391	-5.2160	-1.0687	-8.7940	0.5196	8.7610
EASTENGL	-0.4630	-5.7830	-0.6489	-3.1410	-1.3478	-10.9100	0.7570	12.4140
NW	-1.4077	-19.3890	-1.4044	-6.5600	-1.9103	-16.9060	0.3452	7.9740
NE	-0.9361	-11.1380	-1.2465	-4.9790	-1.4645	-10.7270	0.0462	0.5010
SE	-0.0663	-0.8970	0.0065	0.0360	-0.2645	-2.3080	0.6740	16.7220
SW	-0.0945	-1.2200	-0.4252	-2.2510	-0.8684	-7.1780	0.3707	6.0280
WESTMIDL	-0.4379	-5.9410	-0.3042	-1.6190	-0.5904	-4.8000	0.9922	16.8000
YORK_HUM	-1.2437	-15.8430	-1.3999	-7.3250	-1.2106	-9.3360	0.0418	0.5130
Rho			0.4189	23.0950				
Log likelihood function		-6534.26		-5219.16		-4874.74		
McFadden Pseudo R-squared		0.53		0.20		0.25		
Akaike Information Criterion		0.64		0.51		0.48		
N		20345		20345		20345		

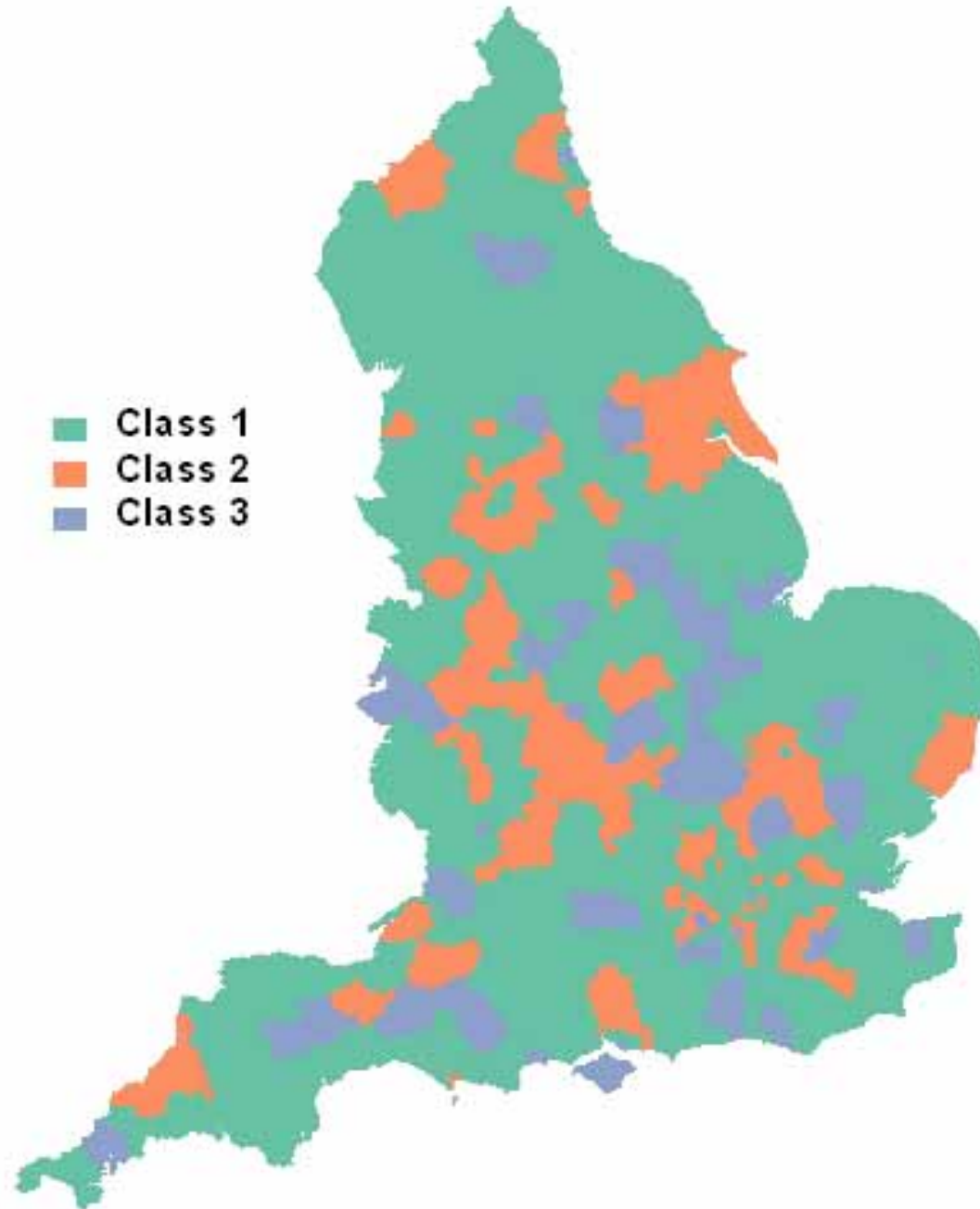
Probit model			Random Effects Probit Model		Random Coefficients Probit Model			
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Means		Scale	
					Coefficient	t-statistic	Coefficient	t-statistic
Constant	3.2286	29.6340	3.5701	19.0740	4.0110	32.2730	0.7084	31.2680
EX_HOU	-2.8981	-35.1630	-3.5898	-69.0630	-3.8656	-55.5440	0.6057	14.8510
EX_COM	-3.5138	-43.0090	-4.1478	-80.0850	-4.4296	-71.7030	0.1918	5.6670
EX_IND	-3.6877	-45.7980	-4.3756	-82.6240	-4.5949	-76.3040	0.1125	4.0070
EX_AGRIC	-2.9731	-23.9290	-3.6714	-55.2640	-3.5522	-29.1100	1.2078	6.1440
EX_REC	-3.0839	-24.4910	-3.9175	-26.6750	-4.2885	-24.9660	0.6521	3.4590
EX_DER	-4.9150	-32.5960	-5.4949	-38.0470	-6.2913	-22.2230	1.1574	4.7410
EX_VAC_B	-4.4027	-33.9130	-4.8808	-45.1240	-5.3451	-40.8390	0.9450	7.0030
EX_VAC_L	-4.6801	-46.6620	-5.2523	-84.6570	-5.7031	-51.4480	1.1565	13.5590
EX_UNUSE	-2.1514	-14.7050	-2.9444	-20.9360	-3.0457	-19.7490	0.3933	2.7420
SMALL	0.1723	4.9740	0.1902	5.3390	0.1725	4.0460	0.3213	11.5010
MEDIUM	0.0026	0.0690	-0.0106	-0.2510	-0.0011	-0.0240	0.1627	4.6340
HOUSE_SU	0.3919	13.2560	0.3522	14.1680	0.3540	9.8460	0.6213	25.5620
PRIVATE	0.3336	12.4810	0.3555	16.4340	0.2601	8.8100	0.4146	18.4260
CITY	0.0422	1.1690	0.1119	2.4820	0.0657	1.3530	0.1684	5.4430
METROPOL	0.3421	6.8380	0.0714	0.8580	0.0228	0.2850	0.1908	4.0500
POP_DENS	0.0010	1.2730	0.0010	0.8340	0.0020	1.5590	0.0030	5.0280
IMD_SCOR	-0.0166	-18.3990	-0.0080	-7.5940	-0.0067	-5.6130	0.0080	11.9660
DIST_50	0.0456	1.2370	-0.0163	-0.4060	0.0041	0.0840	0.1308	4.6390
DIST_75	-0.0980	-2.4220	-0.1252	-2.6880	-0.1200	-2.2750	0.1327	3.0580
EASTMIDL	-0.5519	-6.8840	-1.0391	-5.2160	-1.0687	-8.7940	0.5196	8.7610
EASTENGL	-0.4630	-5.7830	-0.6489	-3.1410	-1.3478	-10.9100	0.7570	12.4140
NW	-1.4077	-19.3890	-1.4044	-6.5600	-1.9103	-16.9060	0.3452	7.9740
NE	-0.9361	-11.1380	-1.2465	-4.9790	-1.4645	-10.7270	0.0462	0.5010
SE	-0.0663	-0.8970	0.0065	0.0360	-0.2645	-2.3080	0.6740	16.7220
SW	-0.0945	-1.2200	-0.4252	-2.2510	-0.8684	-7.1780	0.3707	6.0280
WESTMIDL	-0.4379	-5.9410	-0.3042	-1.6190	-0.5904	-4.8000	0.9922	16.8000
YORK_HUM	-1.2437	-15.8430	-1.3999	-7.3250	-1.2106	-9.3360	0.0418	0.5130
Rho			0.4189	23.0950				
Log likelihood function		-6534.26		-5219.16		-4874.74		
McFadden Pseudo R-squared		0.53		0.20		0.25		
Akaike Information Criterion		0.64		0.51		0.48		
N		20345		20345		20345		

Variable	Probit model		Random Effects Probit Model		Random Coefficients Probit Model			
	Coefficient	t-statistic	Coefficient	t-statistic	Means		Scale	
					Coefficient	t-statistic	Coefficient	t-statistic
Constant	3.2286	29.6340	3.5701	19.0740	4.0110	32.2730	0.7084	31.2680
EX_HOU	-2.8981	-35.1630	-3.5898	-69.0630	-3.8656	-55.5440	0.6057	14.8510
EX_COM	-3.5138	-43.0090	-4.1478	-80.0850	-4.4296	-71.7030	0.1918	5.6670
EX_IND	-3.6877	-45.7980	-4.3756	-82.6240	-4.5949	-76.3040	0.1125	4.0070
EX_AGRIC	-2.9731	-23.9290	-3.6714	-55.2640	-3.5522	-29.1100	1.2078	6.1440
EX_REC	-3.0839	-24.4910	-3.9175	-26.6750	-4.2885	-24.9660	0.6521	3.4590
EX_DER	-4.9150	-32.5960	-5.4949	-38.0470	-6.2913	-22.2230	1.1574	4.7410
EX_VAC_B	-4.4027	-33.9130	-4.8808	-45.1240	-5.3451	-40.8390	0.9450	7.0030
EX_VAC_L	-4.6801	-46.6620	-5.2523	-84.6570	-5.7031	-51.4480	1.1565	13.5590
EX_UNUSE	-2.1514	-14.7050	-2.9444	-20.9360	-3.0457	-19.7490	0.3933	2.7420
SMALL	0.1723	4.9740	0.1902	5.3390	0.1725	4.0460	0.3213	11.5010
MEDIUM	0.0026	0.0690	-0.0106	-0.2510	-0.0011	-0.0240	0.1627	4.6340
HOUSE_SU	0.3919	13.2560	0.3522	14.1680	0.3540	9.8460	0.6213	25.5620
PRIVATE	0.3336	12.4810	0.3555	16.4340	0.2601	8.8100	0.4146	18.4260
CITY	0.0422	1.1690	0.1119	2.4820	0.0657	1.3530	0.1684	5.4430
METROPOL	0.3421	6.8380	0.0714	0.8580	0.0228	0.2850	0.1908	4.0500
POP_DENS	0.0010	1.2730	0.0010	0.8340	0.0020	1.5590	0.0030	5.0280
IMD_SCOR	-0.0166	-18.3990	-0.0080	-7.5940	-0.0067	-5.6130	0.0080	11.9660
DIST_50	0.0456	1.2370	-0.0163	-0.4060	0.0041	0.0840	0.1308	4.6390
DIST_75	-0.0980	-2.4220	-0.1252	-2.6880	-0.1200	-2.2750	0.1327	3.0580
EASTMIDL	-0.5519	-6.8840	-1.0391	-5.2160	-1.0687	-8.7940	0.5196	8.7610
EASTENGL	-0.4630	-5.7830	-0.6489	-3.1410	-1.3478	-10.9100	0.7570	12.4140
NW	-1.4077	-19.3890	-1.4044	-6.5600	-1.9103	-16.9060	0.3452	7.9740
NE	-0.9361	-11.1380	-1.2465	-4.9790	-1.4645	-10.7270	0.0462	0.5010
SE	-0.0663	-0.8970	0.0065	0.0360	-0.2645	-2.3080	0.6740	16.7220
SW	-0.0945	-1.2200	-0.4252	-2.2510	-0.8684	-7.1780	0.3707	6.0280
WESTMIDL	-0.4379	-5.9410	-0.3042	-1.6190	-0.5904	-4.8000	0.9922	16.8000
YORK_HUM	-1.2437	-15.8430	-1.3999	-7.3250	-1.2106	-9.3360	0.0418	0.5130
Rho			0.4189	23.0950				
Log likelihood function		-6534.26		-5219.16		-4874.74		
McFadden Pseudo R-squared		0.53		0.20		0.25		
Akaike Information Criterion		0.64		0.51		0.48		
N		20345		20345		20345		

Latent Class / Panel Probit Model						
Variable	Class 1		Class 2		Class 3	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Constant	3.2270	19.6710	3.4384	15.9070	4.2255	6.8890
EX_HOU	-3.7868	-30.2870	-2.4343	-16.8370	-1.8343	-6.8290
EX_COM	-4.4607	-35.2570	-2.6959	-18.8030	-2.8588	-11.1100
EX_IND	-4.5829	-36.7470	-3.0893	-21.9680	-2.9456	-11.7440
EX_AGRIC	-3.8865	-20.5050	-1.3541	-4.0150	-2.2422	-6.1660
EX_REC	-4.4170	-17.7140	-2.3077	-9.4620	-2.4359	-7.0790
EX_DER	-5.2905	-22.5450	-4.0012	-14.1330	-5.4450	-8.8270
EX_VAC_B	-4.7547	-24.9420	-3.3448	-12.4960	-12.3156	0.0000
EX_VAC_L	-4.5724	-32.1010	-4.8560	-21.2580	-4.7011	-15.4900
EX_UNUSE	-2.9516	-11.6230	-1.7996	-5.9800	-1.9054	-4.5840
SMALL	-0.0780	-1.1890	0.3435	4.9630	0.4369	4.4130
MEDIUM	-0.0957	-1.3590	0.0427	0.5770	0.1203	1.1630
HOUSE_SU	0.4619	8.2860	0.2765	4.9560	0.2696	2.8340
PRIVATE	0.4068	7.8840	0.3234	6.0340	0.1175	1.1560
CITY	0.0649	0.9940	0.0074	0.1010	0.0616	0.6040
METROPOL	0.2273	2.2810	0.2506	2.9000	0.0142	0.0450
POP_DENS	0.0004	0.2950	-0.0006	-0.3780	0.0071	2.4630
IMD_SCOR	-0.0041	-2.5180	-0.0130	-8.1930	-0.0076	-2.2290
DIST_50	-0.0243	-0.3750	-0.1670	-2.1650	0.0791	0.7390
DIST_75	-0.0091	-0.1260	-0.3408	-4.0500	-0.0479	-0.3990
EASTMIDL	-0.8506	-5.8720	-0.1856	-1.0980	-2.3428	-4.1810
EASTENGL	-0.6710	-4.6800	-0.2119	-1.2000	-2.3219	-4.1430
NW	-1.4833	-12.5370	-1.4333	-9.8060	-1.2723	-2.1410
NE	-1.2551	-8.0740	-1.2611	-8.1900	-1.2791	-2.1340
SE	0.1281	1.0590	0.4626	2.8270	-1.8411	-3.2840
SW	0.0571	0.4530	-0.7606	-4.5130	-1.1274	-2.0260
WESTMIDL	-1.2079	-8.0310	-0.9830	-6.9290	-0.5758	-1.0130
YORK_HUM	-1.5079	-10.9540	-1.6763	-10.3240	-1.8667	-3.4880
Estimated prior probabilities for class membership	Probability	t-statistic	Probability	t-statistic	Probability	t-statistic
	0.62	21.464	0.22	8.528	0.16	6.996
Log likelihood function	-5164.38					
McFadden Pseudo R-squared	0.21					
Akaike Information Criterion	0.51					
N	20345					

Latent Class / Panel Probit Model						
Variable	Class 1		Class 2		Class 3	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Constant	3.2270	19.6710	3.4384	15.9070	4.2255	6.8890
EX_HOU	-3.7868	-30.2870	-2.4343	-16.8370	-1.8343	-6.8290
EX_COM	-4.4607	-35.2570	-2.6959	-18.8030	-2.8588	-11.1100
EX_IND	-4.5829	-36.7470	-3.0893	-21.9680	-2.9456	-11.7440
EX_AGRIC	-3.8865	-20.5050	-1.3541	-4.0150	-2.2422	-6.1660
EX_REC	-4.4170	-17.7140	-2.3077	-9.4620	-2.4359	-7.0790
EX_DER	-5.2905	-22.5450	-4.0012	-14.1330	-5.4450	-8.8270
EX_VAC_B	-4.7547	-24.9420	-3.3448	-12.4960	-12.3156	0.0000
EX_VAC_L	-4.5724	-32.1010	-4.8560	-21.2580	-4.7011	-15.4900
EX_UNUSE	-2.9516	-11.6230	-1.7996	-5.9800	-1.9054	-4.5840
SMALL	-0.0780	-1.1890	0.3435	4.9630	0.4369	4.4130
MEDIUM	-0.0957	-1.3590	0.0427	0.5770	0.1203	1.1630
HOUSE_SU	0.4619	8.2860	0.2765	4.9560	0.2696	2.8340
PRIVATE	0.4068	7.8840	0.3234	6.0340	0.1175	1.1560
CITY	0.0649	0.9940	0.0074	0.1010	0.0616	0.6040
METROPOL	0.2273	2.2810	0.2506	2.9000	0.0142	0.0450
POP_DENS	0.0004	0.2950	-0.0006	-0.3780	0.0071	2.4630
IMD_SCOR	-0.0041	-2.5180	-0.0130	-8.1930	-0.0076	-2.2290
DIST_50	-0.0243	-0.3750	-0.1670	-2.1650	0.0791	0.7390
DIST_75	-0.0091	-0.1260	-0.3408	-4.0500	-0.0479	-0.3990
EASTMIDL	-0.8506	-5.8720	-0.1856	-1.0980	-2.3428	-4.1810
EASTENGL	-0.6710	-4.6800	-0.2119	-1.2000	-2.3219	-4.1430
NW	-1.4833	-12.5370	-1.4333	-9.8060	-1.2723	-2.1410
NE	-1.2551	-8.0740	-1.2611	-8.1900	-1.2791	-2.1340
SE	0.1281	1.0590	0.4626	2.8270	-1.8411	-3.2840
SW	0.0571	0.4530	-0.7606	-4.5130	-1.1274	-2.0260
WESTMIDL	-1.2079	-8.0310	-0.9830	-6.9290	-0.5758	-1.0130
YORK_HUM	-1.5079	-10.9540	-1.6763	-10.3240	-1.8667	-3.4880
Estimated prior probabilities for class membership	Probability	t-statistic	Probability	t-statistic	Probability	t-statistic
	0.62	21.464	0.22	8.528	0.16	6.996
Log likelihood function	-5164.38					
McFadden Pseudo R-squared	0.21					
Akaike Information Criterion	0.51					
N	20345					

Latent Class Model: Three classes of local authorities



Conclusions

- The brownfield community has done some progress in redeveloping previously developed sites, but...
- ... difficult sites
 - large sites
 - previous commercial and industrial activities
 - sites located in the poorer and bleakest areas of cities and regions of England
 - **publicly owned** sites
- No clear trend in regeneration between urban Vs rural brownfields

The Data (cont.)

NLUD has been augmented with GIS data to answer our research questions :

- the population density of the wards where the sites are located
- whether the site is located in a city, a metropolis or a rural area
- the Index of Multiple Deprivation for 2004 for the super output areas where sites are located
- the distances to the central business district