

A multi-scale story of the diffusion of a new technology: the Web

A. Appendix

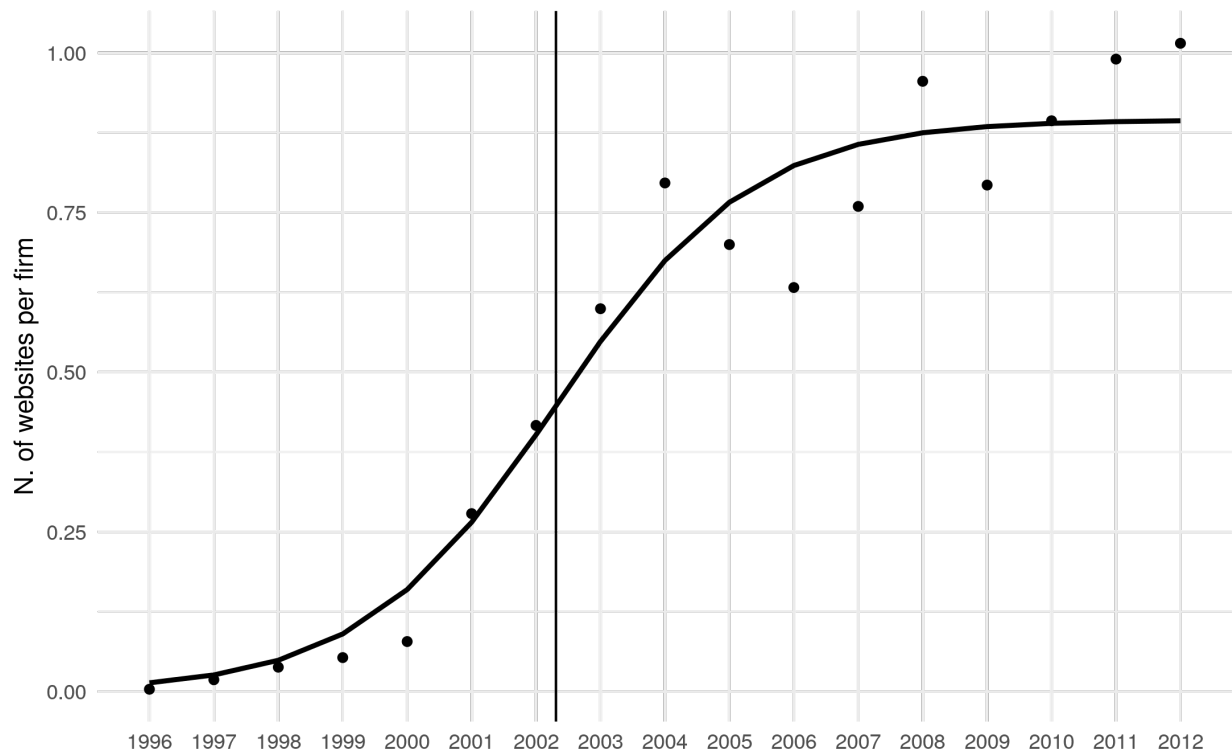


Figure A.1: Cumulative adoption of the Web, UK; up to 10 postcodes per website

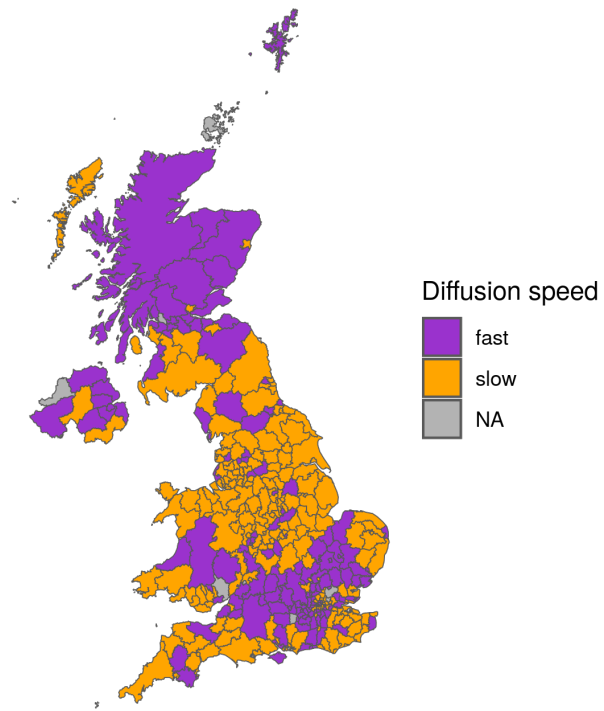


Figure A.2: LAD Web diffusion speed, 1996-2012; up to 10 postcodes per website

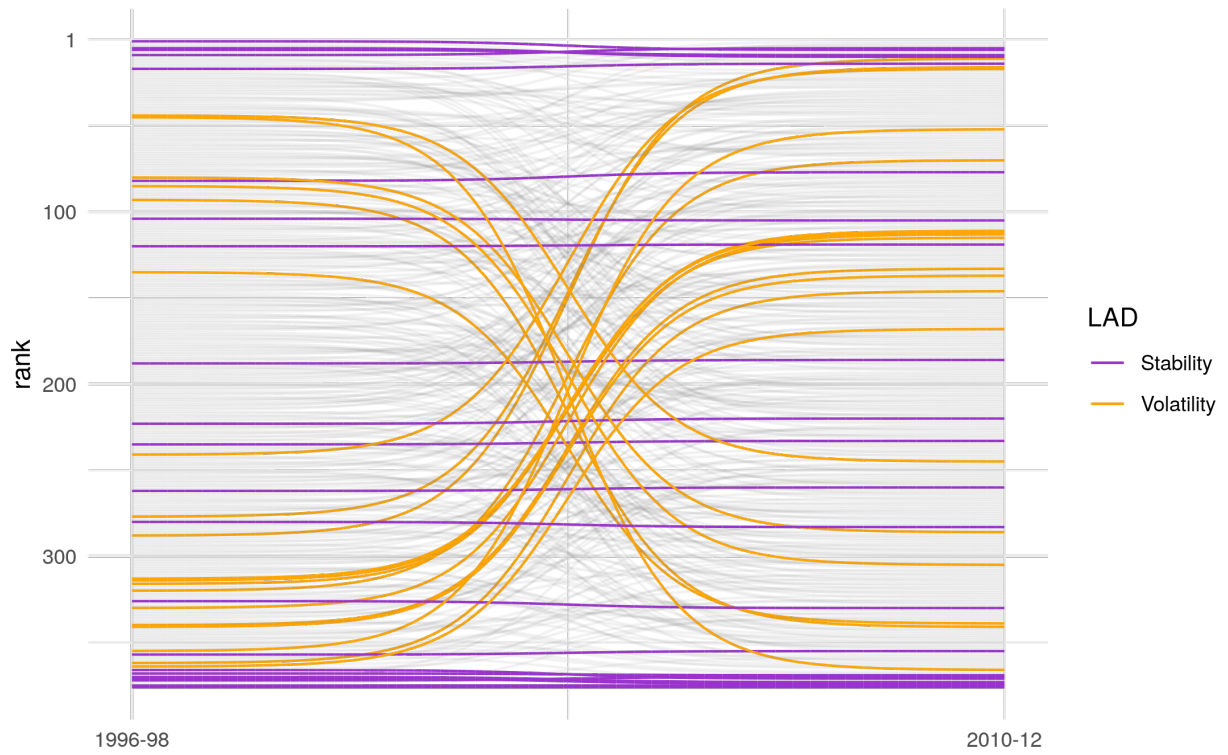


Figure A.3: Dynamics of Web diffusion based on LAD rankings; up to 10 postcodes per website

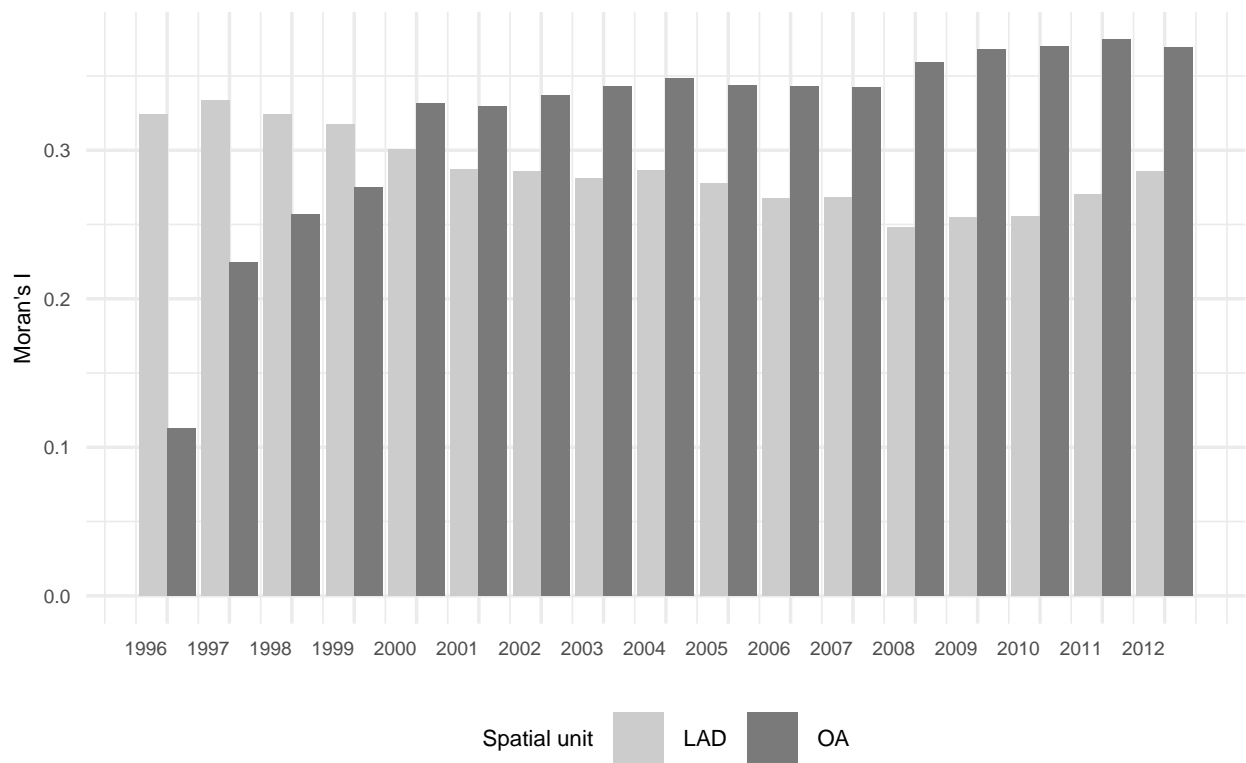


Figure A.4: Website density Moran's I; up to 10 postcodes per website

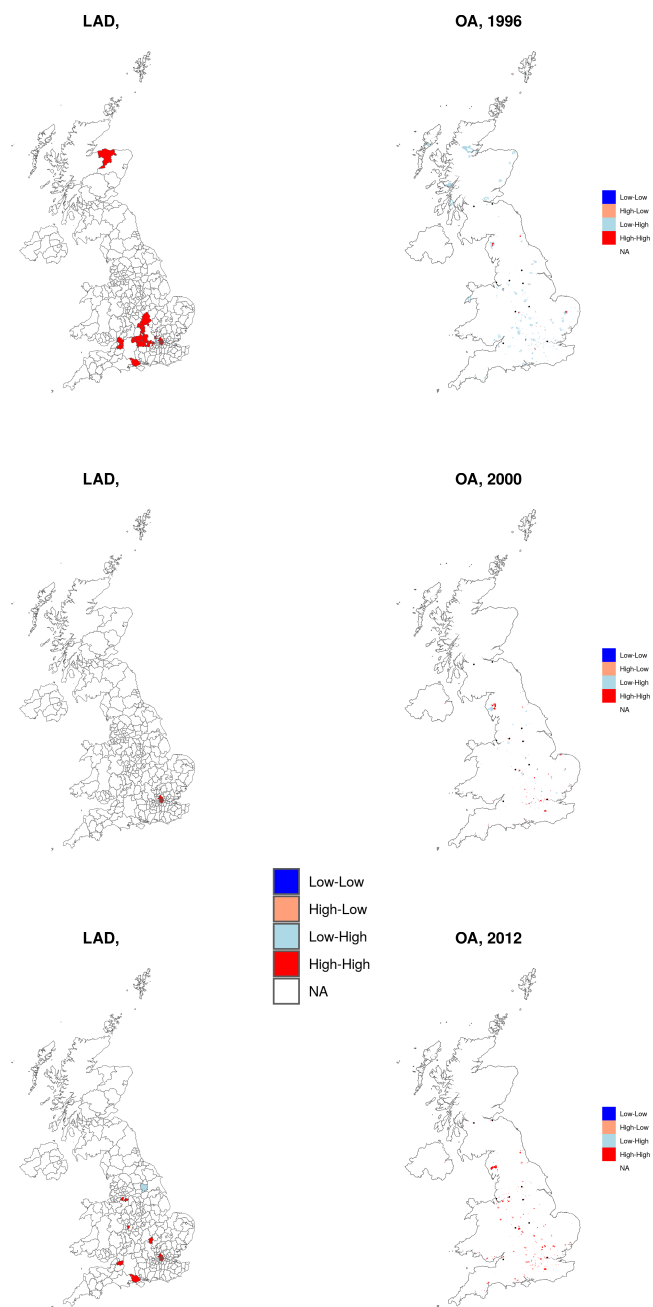


Figure A.5: Website density LISA maps; up to 10 postcodes per website

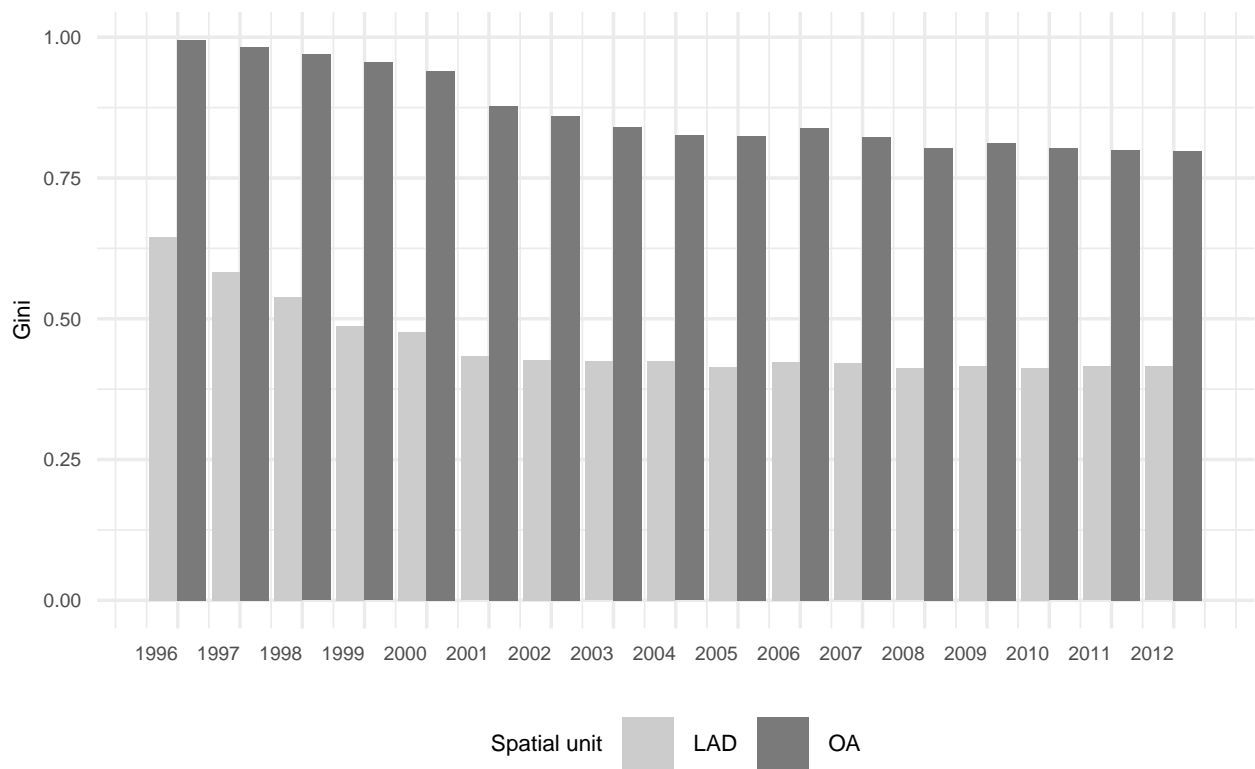


Figure A.6: Website density Gini coefficient; up to 10 postcodes per website

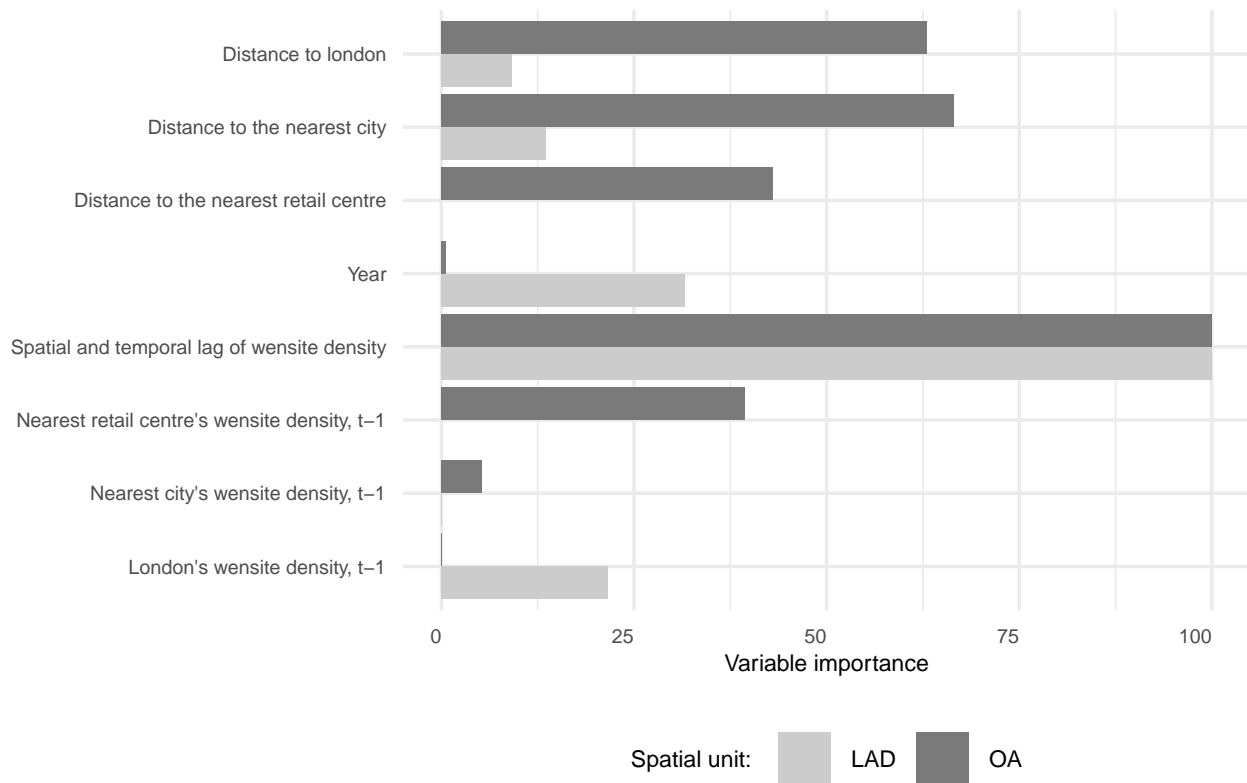


Figure A.7: Variable importance; up to 10 postcodes per website

Table A.1: S-curve estimates for LAD

LAD	Region	t_0 estimate	Std. error	R^2	Diffusion speed
Horsham	South East	2001.423	0.254	0.950	fast
Fareham	South East	2001.443	0.346	0.925	fast
Kingston upon Thames	London	2001.513	0.354	0.933	fast
Kensington and Chelsea	London	2001.581	0.341	0.943	fast
Runnymede	South East	2001.582	0.266	0.943	fast
Bracknell Forest	South East	2001.586	0.324	0.928	fast
Elmbridge	South East	2001.656	0.333	0.932	fast
Reigate and Banstead	South East	2001.665	0.253	0.964	fast
South Cambridgeshire	East of England	2001.680	0.433	0.905	fast
Walsall	West Midlands	2001.715	0.413	0.901	fast
Surrey Heath	South East	2001.718	0.333	0.933	fast
Woking	South East	2001.759	0.292	0.951	fast
South Norfolk	East of England	2001.874	0.358	0.931	fast
City of London	London	2001.874	0.499	0.930	fast
Wokingham	South East	2001.891	0.287	0.958	fast
Reading	South East	2001.900	0.318	0.948	fast
Sevenoaks	South East	2001.904	0.407	0.926	fast
Huntingdonshire	East of England	2001.912	0.402	0.925	fast
Pendle	North West	2001.924	0.407	0.923	fast
St Albans	East of England	2001.933	0.396	0.927	fast

LAD	Region	t_0 estimate	Std. error	R^2	Diffusion speed
Perth and Kinross	NA	2001.943	0.228	0.970	fast
Bromley	London	2001.945	0.396	0.919	fast
Rushmoor	South East	2001.962	0.518	0.912	fast
Powys	NA	2001.969	0.278	0.963	fast
Swindon	South West	2001.996	0.390	0.916	fast
Chelmsford	East of England	2002.008	0.545	0.911	fast
Crawley	South East	2002.008	0.379	0.949	fast
Dumfries and Galloway	NA	2002.012	0.251	0.967	fast
Inverclyde	NA	2002.030	0.330	0.915	fast
North Hertfordshire	East of England	2002.031	0.475	0.920	fast
Moray	NA	2002.050	0.358	0.947	fast
Orkney Islands	NA	2002.070	0.283	0.958	fast
Fife	NA	2002.070	0.363	0.945	fast
Mole Valley	South East	2002.071	0.460	0.925	fast
Guildford	South East	2002.113	0.413	0.941	fast
Buckinghamshire	South East	2002.114	0.390	0.942	fast
Cotswold	South West	2002.116	0.375	0.946	fast
Shetland Islands	NA	2002.120	0.332	0.949	fast
South Oxfordshire	South East	2002.146	0.367	0.950	fast
Watford	East of England	2002.157	0.451	0.929	fast
Aberdeenshire	NA	2002.168	0.416	0.931	fast
Southampton	South East	2002.189	0.472	0.922	fast
Mid Suffolk	East of England	2002.196	0.442	0.922	fast
Eden	North West	2002.196	0.334	0.949	fast
South Lakeland	North West	2002.197	0.238	0.974	fast
Stoke-on-Trent	West Midlands	2002.203	0.419	0.927	fast
Babergh	East of England	2002.209	0.449	0.927	fast
Bexley	London	2002.213	0.493	0.909	fast
Torbay	South West	2002.215	0.374	0.942	fast
Brentwood	East of England	2002.219	0.336	0.936	fast
Ceredigion	NA	2002.227	0.241	0.971	fast
Spelthorne	South East	2002.232	0.451	0.933	fast
Bath and North East Somerset	South West	2002.238	0.402	0.941	fast
Falkirk	NA	2002.245	0.367	0.938	fast
Broxtowe	East Midlands	2002.258	0.435	0.932	fast
East Hertfordshire	East of England	2002.261	0.453	0.928	fast
Stirling	NA	2002.268	0.251	0.975	fast
Ealing	London	2002.294	0.523	0.922	fast
Mid Sussex	South East	2002.295	0.453	0.936	fast
Barrow-in-Furness	North West	2002.303	0.284	0.959	fast
West Oxfordshire	South East	2002.322	0.467	0.929	fast
Sutton	London	2002.326	0.544	0.911	fast
Portsmouth	South East	2002.356	0.479	0.921	fast
Great Yarmouth	East of England	2002.369	0.265	0.968	fast
East Hampshire	South East	2002.370	0.474	0.931	fast
Wyre Forest	West Midlands	2002.376	0.561	0.916	fast
Angus	NA	2002.378	0.396	0.939	fast
Argyll and Bute	NA	2002.427	0.321	0.962	fast

LAD	Region	t_0 estimate	Std. error	R^2	Diffusion speed
Scottish Borders	NA	2002.428	0.298	0.962	fast
East Suffolk	East of England	2002.431	0.533	0.919	fast
Blackpool	North West	2002.443	0.294	0.962	fast
Cherwell	South East	2002.448	0.533	0.923	fast
Wandsworth	London	2002.449	0.570	0.921	fast
Tendring	East of England	2002.456	0.456	0.935	fast
Westminster	London	2002.459	0.437	0.952	fast
Richmond upon Thames	London	2002.462	0.389	0.956	fast
Test Valley	South East	2002.463	0.553	0.920	fast
Isle of Wight	South East	2002.478	0.377	0.953	fast
Vale of White Horse	South East	2002.496	0.408	0.949	fast
Croydon	London	2002.510	0.504	0.927	fast
Hounslow	London	2002.521	0.426	0.952	fast
Copeland	North West	2002.524	0.237	0.971	fast
Wiltshire	South West	2002.528	0.450	0.940	fast
Gwynedd	NA	2002.536	0.372	0.954	fast
Hillingdon	London	2002.560	0.470	0.940	fast
Conwy	NA	2002.564	0.372	0.954	fast
Highland	NA	2002.566	0.270	0.972	fast
Basingstoke and Deane	South East	2002.572	0.461	0.947	fast
Harrow	London	2002.587	0.509	0.936	fast
West Berkshire	South East	2002.595	0.696	0.902	fast
North Lincolnshire	Yorkshire and The Humber	2002.596	0.501	0.933	fast
East Dunbartonshire	NA	2002.598	0.528	0.925	fast
Bradford	Yorkshire and The Humber	2002.598	0.613	0.916	fast
Waverley	South East	2002.606	0.512	0.928	fast
Stroud	South West	2002.608	0.559	0.916	fast
Herefordshire, County of	West Midlands	2002.622	0.388	0.956	fast
North Norfolk	East of England	2002.624	0.422	0.945	fast
Nottingham	East Midlands	2002.630	0.531	0.936	fast
Castle Point	East of England	2002.645	0.470	0.936	fast
North Warwickshire	West Midlands	2002.657	0.380	0.955	fast
Gravesham	South East	2002.680	0.473	0.933	fast
Lancaster	North West	2002.692	0.336	0.963	fast
West Suffolk	East of England	2002.699	0.536	0.930	fast
Stafford	West Midlands	2002.719	0.499	0.933	fast
Tunbridge Wells	South East	2002.720	0.401	0.958	fast
Oxford	South East	2002.723	0.583	0.934	fast
East Lothian	NA	2002.731	0.537	0.927	fast
Redcar and Cleveland	North East	2002.750	0.509	0.929	fast
Tamworth	West Midlands	2002.755	0.551	0.929	fast
South Hams	South West	2002.773	0.422	0.952	fast
Allerdale	North West	2002.784	0.376	0.958	fast
Central Bedfordshire	East of England	2002.825	0.620	0.921	fast
East Cambridgeshire	East of England	2002.843	0.636	0.927	fast
Havant	South East	2002.853	0.541	0.932	fast
South Lanarkshire	NA	2002.874	0.486	0.938	fast

LAD	Region	t_0 estimate	Std. error	R^2	Diffusion speed
Stratford-on-Avon	West Midlands	2002.879	0.470	0.945	fast
Arun	South East	2002.882	0.526	0.938	fast
Fenland	East of England	2002.891	0.632	0.918	fast
Monmouthshire	NA	2002.893	0.501	0.935	fast
Denbighshire	NA	2002.901	0.457	0.947	fast
Southend-on-Sea	East of England	2002.903	0.551	0.932	fast
High Peak	East Midlands	2002.903	0.488	0.946	fast
Pembrokeshire	NA	2002.905	0.387	0.958	fast
Malvern Hills	West Midlands	2002.907	0.524	0.940	fast
Camden	London	2002.915	0.599	0.941	fast
North Devon	South West	2002.926	0.426	0.950	fast
Wyre	North West	2002.927	0.553	0.927	fast
Darlington	North East	2002.933	0.615	0.929	fast
Swale	South East	2002.940	0.447	0.948	fast
Welwyn Hatfield	East of England	2002.951	0.628	0.922	fast
Mid Devon	South West	2002.960	0.485	0.946	fast
Lewes	South East	2002.964	0.507	0.945	fast
Dorset	South West	2002.968	0.407	0.958	fast
Brighton and Hove	South East	2002.976	0.578	0.934	fast
Braintree	East of England	2002.978	0.534	0.938	fast
Epsom and Ewell	South East	2002.979	0.746	0.908	fast
Sefton	North West	2002.980	0.616	0.928	fast
Eastleigh	South East	2002.992	0.595	0.929	fast
Craven	Yorkshire and The Humber	2002.993	0.379	0.965	fast
Hammersmith and Fulham	London	2002.997	0.585	0.944	fast
Greenwich	London	2003.014	0.571	0.930	slow
Cheltenham	South West	2003.025	0.602	0.937	slow
Worcester	West Midlands	2003.041	0.659	0.920	slow
Tower Hamlets	London	2003.043	0.660	0.926	slow
New Forest	South East	2003.046	0.554	0.941	slow
East Renfrewshire	NA	2003.046	0.739	0.900	slow
Fylde	North West	2003.056	0.501	0.946	slow
Carmarthenshire	NA	2003.067	0.390	0.958	slow
West Lancashire	North West	2003.076	0.547	0.937	slow
Hastings	South East	2003.086	0.685	0.911	slow
Carlisle	North West	2003.111	0.541	0.934	slow
Wychavon	West Midlands	2003.115	0.570	0.935	slow
Isle of Anglesey	NA	2003.144	0.403	0.960	slow
Dudley	West Midlands	2003.150	0.678	0.925	slow
Ryedale	Yorkshire and The Humber	2003.152	0.380	0.961	slow
Rother	South East	2003.162	0.366	0.966	slow
Leicester	East Midlands	2003.167	0.686	0.924	slow
Breckland	East of England	2003.182	0.567	0.938	slow
Tandridge	South East	2003.190	0.747	0.918	slow
Shropshire	West Midlands	2003.206	0.621	0.928	slow
West Devon	South West	2003.228	0.489	0.949	slow
Milton Keynes	South East	2003.231	0.700	0.929	slow

LAD	Region	t_0 estimate	Std. error	R^2	Diffusion speed
Sandwell	West Midlands	2003.234	0.760	0.916	slow
Winchester	South East	2003.234	0.443	0.956	slow
Redditch	West Midlands	2003.238	0.706	0.923	slow
Rugby	West Midlands	2003.265	0.709	0.922	slow
North Somerset	South West	2003.278	0.558	0.939	slow
West Lindsey	East Midlands	2003.285	0.674	0.924	slow
Richmondshire	Yorkshire and The Humber	2003.286	0.425	0.958	slow
Melton	East Midlands	2003.292	0.534	0.946	slow
Chichester	South East	2003.295	0.582	0.942	slow
Torridge	South West	2003.301	0.532	0.942	slow
Dundee City	NA	2003.303	0.568	0.939	slow
South Ayrshire	NA	2003.303	0.626	0.931	slow
East Devon	South West	2003.308	0.492	0.947	slow
Bolton	North West	2003.323	0.774	0.913	slow
Hertsmere	East of England	2003.326	0.726	0.924	slow
Bournemouth, Christchurch and Poole	South West	2003.347	0.662	0.936	slow
Maldon	East of England	2003.349	0.495	0.951	slow
Barnet	London	2003.352	0.766	0.919	slow
Brent	London	2003.389	0.762	0.925	slow
Midlothian	NA	2003.413	0.732	0.921	slow
Boston	East Midlands	2003.416	0.593	0.933	slow
Scarborough	Yorkshire and The Humber	2003.421	0.431	0.963	slow
Kirklees	Yorkshire and The Humber	2003.435	0.725	0.925	slow
Tameside	North West	2003.441	0.819	0.907	slow
Newport	NA	2003.449	0.635	0.930	slow
Glasgow City	NA	2003.451	0.759	0.922	slow
Clackmannanshire	NA	2003.454	0.585	0.936	slow
Three Rivers	East of England	2003.458	0.628	0.947	slow
Harborough	East Midlands	2003.488	0.549	0.950	slow
Rochdale	North West	2003.496	0.685	0.937	slow
Tonbridge and Malling	South East	2003.497	0.710	0.927	slow
Somerset West and Taunton	South West	2003.502	0.491	0.955	slow
Wrexham	NA	2003.512	0.553	0.942	slow
Worthing	South East	2003.522	0.622	0.938	slow
Tewkesbury	South West	2003.540	0.580	0.946	slow
City of Edinburgh	NA	2003.541	0.685	0.941	slow
Coventry	West Midlands	2003.592	0.564	0.948	slow
Northumberland	North East	2003.607	0.508	0.954	slow
Mid and East Antrim	NA	2003.609	0.893	0.900	slow
Wigan	North West	2003.617	0.755	0.929	slow
Lichfield	West Midlands	2003.629	0.625	0.939	slow
Ashford	South East	2003.633	0.535	0.944	slow
Cornwall	South West	2003.638	0.443	0.963	slow
Mendip	South West	2003.652	0.505	0.955	slow
Stevenage	East of England	2003.665	0.525	0.958	slow

LAD	Region	t_0 estimate	Std. error	R^2	Diffusion speed
Blaenau Gwent	NA	2003.666	0.643	0.933	slow
Lincoln	East Midlands	2003.666	0.634	0.940	slow
South Somerset	South West	2003.676	0.553	0.948	slow
Charnwood	East Midlands	2003.677	0.699	0.934	slow
North Ayrshire	NA	2003.682	0.607	0.942	slow
Folkestone and Hythe	South East	2003.684	0.792	0.905	slow
Eastbourne	South East	2003.684	0.697	0.930	slow
Blackburn with Darwen	North West	2003.685	0.680	0.938	slow
Dover	South East	2003.699	0.574	0.948	slow
Adur	South East	2003.735	0.551	0.954	slow
Haringey	London	2003.739	0.667	0.943	slow
Gosport	South East	2003.751	0.600	0.934	slow
Trafford	North West	2003.752	0.640	0.949	slow
Norwich	East of England	2003.756	0.742	0.939	slow
West Lothian	NA	2003.758	0.652	0.943	slow
North East Lincolnshire	Yorkshire and The Humber	2003.811	0.858	0.920	slow
Bristol, City of	South West	2003.828	0.831	0.928	slow
Rushcliffe	East Midlands	2003.839	0.591	0.954	slow
Hinckley and Bosworth	East Midlands	2003.857	0.749	0.934	slow
Torfaen	NA	2003.861	0.841	0.922	slow
Swansea	NA	2003.875	0.650	0.947	slow
Wolverhampton	West Midlands	2003.882	0.793	0.931	slow
Kingston upon Hull, City of	Yorkshire and The Humber	2003.885	0.757	0.936	slow
Calderdale	Yorkshire and The Humber	2003.889	0.714	0.939	slow
North Northamptonshire	East Midlands	2003.902	0.746	0.935	slow
Stockton-on-Tees	North East	2003.902	0.955	0.916	slow
Wealden	South East	2003.906	0.736	0.938	slow
Thanet	South East	2003.953	0.667	0.947	slow
Broadland	East of England	2003.962	0.727	0.938	slow
West Northamptonshire	East Midlands	2003.972	0.736	0.940	slow
North Kesteven	East Midlands	2003.976	0.633	0.942	slow
Neath Port Talbot	NA	2003.981	0.767	0.933	slow
Rhondda Cynon Taf	NA	2003.991	0.769	0.925	slow
Enfield	London	2003.992	0.588	0.954	slow
East Lindsey	East Midlands	2004.010	0.577	0.952	slow
Teignbridge	South West	2004.015	0.681	0.941	slow
York	Yorkshire and The Humber	2004.025	0.739	0.944	slow
Harlow	East of England	2004.030	0.803	0.936	slow
Vale of Glamorgan	NA	2004.033	0.592	0.951	slow
Newark and Sherwood	East Midlands	2004.034	0.668	0.946	slow
Merton	London	2004.041	0.932	0.922	slow
Hambleton	Yorkshire and The Humber	2004.065	0.636	0.953	slow
Bedford	East of England	2004.068	0.852	0.933	slow
Stockport	North West	2004.075	0.757	0.942	slow

LAD	Region	t_0 estimate	Std. error	R^2	Diffusion speed
South Ribble	North West	2004.126	0.674	0.948	slow
Uttlesford	East of England	2004.144	0.905	0.926	slow
Rossendale	North West	2004.160	0.976	0.923	slow
Oldham	North West	2004.162	0.801	0.938	slow
Sheffield	Yorkshire and The Humber	2004.189	0.770	0.944	slow
Ribble Valley	North West	2004.204	0.718	0.945	slow
Maidstone	South East	2004.222	0.854	0.932	slow
Cheshire West and Chester	North West	2004.234	0.742	0.947	slow
Thurrock	East of England	2004.241	0.841	0.924	slow
Telford and Wrekin	West Midlands	2004.241	1.024	0.917	slow
Cardiff	NA	2004.246	0.823	0.937	slow
County Durham	North East	2004.250	0.626	0.953	slow
Plymouth	South West	2004.252	0.785	0.934	slow
Bridgend	NA	2004.256	0.547	0.956	slow
Rotherham	Yorkshire and The Humber	2004.273	0.722	0.938	slow
Hyndburn	North West	2004.298	0.881	0.932	slow
Newcastle upon Tyne	North East	2004.305	0.906	0.932	slow
Wakefield	Yorkshire and The Humber	2004.314	0.905	0.923	slow
Havering	London	2004.345	0.822	0.938	slow
South Kesteven	East Midlands	2004.353	1.026	0.915	slow
Canterbury	South East	2004.354	0.602	0.960	slow
Broxbourne	East of England	2004.363	0.817	0.944	slow
Peterborough	East of England	2004.382	0.937	0.932	slow
Redbridge	London	2004.411	1.028	0.925	slow
Bury	North West	2004.431	0.735	0.953	slow
Harrogate	Yorkshire and The Humber	2004.433	0.971	0.927	slow
Birmingham	West Midlands	2004.435	1.182	0.912	slow
South Tyneside	North East	2004.446	0.636	0.948	slow
Chorley	North West	2004.462	1.093	0.913	slow
North East Derbyshire	East Midlands	2004.483	0.703	0.953	slow
Lambeth	London	2004.485	0.958	0.937	slow
Doncaster	Yorkshire and The Humber	2004.496	0.672	0.953	slow
South Gloucestershire	South West	2004.499	0.881	0.937	slow
Caerphilly	NA	2004.499	0.819	0.938	slow
East Staffordshire	West Midlands	2004.501	1.132	0.910	slow
North Tyneside	North East	2004.509	0.864	0.933	slow
South Holland	East Midlands	2004.534	0.851	0.941	slow
Gateshead	North East	2004.535	0.869	0.934	slow
St. Helens	North West	2004.542	1.097	0.923	slow
Flintshire	NA	2004.549	0.764	0.951	slow
Selby	Yorkshire and The Humber	2004.549	0.716	0.947	slow
Belfast	NA	2004.556	1.332	0.906	slow
Sedgemoor	South West	2004.613	0.540	0.966	slow

LAD	Region	t_0 estimate	Std. error	R^2	Diffusion speed
Exeter	South West	2004.617	0.964	0.936	slow
South Derbyshire	East Midlands	2004.629	0.934	0.938	slow
Derbyshire Dales	East Midlands	2004.668	0.648	0.963	slow
East Riding of Yorkshire	Yorkshire and The Humber	2004.683	0.728	0.955	slow
Basildon	East of England	2004.691	1.067	0.925	slow
Barking and Dagenham	London	2004.800	1.198	0.916	slow
Causeway Coast and Glens	NA	2004.834	1.024	0.928	slow
North Lanarkshire	NA	2004.839	0.878	0.945	slow
Chesterfield	East Midlands	2004.887	1.173	0.927	slow
Newcastle-under-Lyme	West Midlands	2004.933	1.172	0.925	slow
East Ayrshire	NA	2004.934	1.280	0.903	slow
Nuneaton and Bedworth	West Midlands	2004.956	0.950	0.941	slow
Blaby	East Midlands	2004.959	1.059	0.929	slow
Leeds	Yorkshire and The Humber	2004.979	0.836	0.956	slow
Erewash	East Midlands	2004.987	0.939	0.944	slow
Bassetlaw	East Midlands	2004.998	0.982	0.944	slow
Hackney	London	2005.026	1.157	0.934	slow
Barnsley	Yorkshire and The Humber	2005.055	0.912	0.942	slow
Amber Valley	East Midlands	2005.105	1.017	0.941	slow
Colchester	East of England	2005.144	1.250	0.927	slow
Ashfield	East Midlands	2005.176	1.073	0.942	slow
Wirral	North West	2005.184	1.084	0.939	slow
Knowsley	North West	2005.186	1.160	0.923	slow
Windsor and Maidenhead	South East	2005.195	1.746	0.902	slow
Bromsgrove	West Midlands	2005.494	1.144	0.941	slow
Liverpool	North West	2005.526	1.276	0.936	slow
Staffordshire Moorlands	West Midlands	2005.583	1.426	0.924	slow
Islington	London	2005.970	1.223	0.955	slow
Warrington	North West	2006.015	1.387	0.942	slow
Newham	London	2006.078	1.908	0.907	slow
Bolsover	East Midlands	2006.188	1.143	0.957	slow
Lisburn and Castlereagh	NA	2006.193	1.970	0.903	slow
Manchester	North West	2006.449	1.434	0.950	slow
Sunderland	North East	2006.479	1.679	0.928	slow
South Staffordshire	West Midlands	2006.490	1.837	0.922	slow
Rutland	East Midlands	2006.529	0.986	0.967	slow
Cannock Chase	West Midlands	2006.700	2.231	0.917	slow
Mansfield	East Midlands	2006.889	1.579	0.946	slow
Ards and North Down	NA	2006.947	2.485	0.907	slow
Halton	North West	2007.069	0.932	0.967	slow
Burnley	North West	2007.372	2.286	0.919	slow
Middlesbrough	North East	2010.074	5.297	0.900	slow
Isles of Scilly	South West	2012.163	4.257	0.953	slow

Table A.2: Regional differences; up to 10 postcodes per website

Region	R^2 LAD	Rank LAD	R^2 OA	Rank OA
Yorkshire and The Humber	0.864	1	0.191	5
West Midlands	0.860	2	0.148	8
South East	0.848	3	0.171	7
North West	0.827	4	0.221	1
London	0.826	5	0.118	9
South West	0.801	6	0.194	4
Wales	0.746	7	0.114	11
East Midlands	0.732	8	0.117	10
East of England	0.731	9	0.178	6
North East	0.695	10	0.215	2
Scotland	0.588	11	0.052	12
Northern Ireland	0.488	12	0.197	3

Table A.3: Model metrics for growth model

	$RMSE$	R^2	MAE
Local Authorities	0.286	0.506	0.223

Table A.3 presents the results of a Random Forest model that was trained based on Equation A1 using all LAD data points. In essence, this is a model similar to the one estimated based on Equation 3 and presented in Table 2, with the main difference being the dependent variable which is the year growth rate of website density for each LAD. To avoid cases with LAD have no websites, $t \in [2000, 2012]$. The high predictive capability of the model reflects the robustness of the modelling approach.

$$\begin{aligned}
Website\ Density\ Growth_t \sim & Distance\ London + Website\ density\ London_{t-1} + \\
& Distance\ Nearest\ City + Website\ density\ Nearest\ City_{t-1} + \\
& Distance\ Nearest\ Retail_i + Website\ density\ Nearest\ Retail_{t-1} + \\
& W * Website\ density_{t-1} + \\
& year_t
\end{aligned} \tag{A1}$$