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Evaluation of the National Strategy for Neighbourhood Renewal: Econometric modelling of neighbourhood change

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March 2010

Pion Economics
Prepared in association with AMION Consulting
Department for Communities and Local Government

The findings and recommendations in this report are those of the authors and do not necessarily represent the views of the Department for Communities and Local Government.

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March 2010

Product Code: 09ACST06223

ISBN 978-1-4098-2210-3

Contents

1 Introduction

This paper outlines the methodology adopted to examine area change as part of the national evaluation of the National Strategy for Neighbourhood Renewal (NSNR) led by AMION Consulting Ltd.

One of the primary objectives of the methodology is to examine what areas appear to improve or decline and whether it is feasible to assess what factors contribute to the process of change. The improvement or decline of areas between different states is known as ‘area transition’.

A major constraint on this type of analysis in the past has been the absence of robust local level information detailing the relative status of small areas over time. This gap is now being addressed with lower layer super output area (LSOA) data supplied by the Social Disadvantage Research Centre (SDRC) at Oxford University.

This paper focuses primarily on modelling the likelihood of area transition between 2001 and 2006 and reviews the relative importance of social, economic and policy factors to the likelihood of change. The approach adopted within the paper is to:

- define appropriate transition matrices relating to worklessness using SDRC LSOA based information[1]
- construct and estimate binary models of transition employing discrete dependent variable based methods; and
- examine and reflect on the role and importance of underlying social, economic and policy factors in explaining the transition process.

Section 2 illustrates the approach taken to the definition of area transition; Section 3 describes the datasets employed to assess relationships between transition profiles and underlying socio-economic structures; Section 4 outlines the statistical basis of the modelling approach adopted as well as emerging findings and Section 5 highlights simulation profiles.

1 Worklessness is defined with regard to beneficiaries of Incapacity Benefit (IB), Severe Disability Allowance (SDA) and Jobseekers Allowance (JSA).

2 Defining area transition

Local neighbourhoods are constantly in a state of flux. The dynamics of labour and housing markets, proximity to centres of employment, access to transport and demographic change are constantly interacting to define the development potential of areas, as well as to reflect patterns of existing performance.

A number of potential mechanisms exist through which to define area transition within the context of a specific variable.[2] The most obvious relates to the position of an area in the distribution of values at different points in time. For example, an LSOA with a 5 per cent worklessness rate in 2006 compared to a rate of 10 per cent in 2001 has clearly improved in absolute terms over that time period. On the other hand, in the event that other LSOAs have experienced similar patterns of change, it may be in no better relative position, and may conceivably be worse off.

The work reported in this paper adopts a relative measure of change that is consistent with the general approach of the wider evaluation of the NSNR. As such, area transitions are defined in the context of neighbourhood[3] worklessness rates relative to the average Local Authority District (LAD) rate at different points in time.

It would be feasible to apply a base other than that for the host LAD, but as the reference area widens, the further one moves from considering LSOAs in their local context. Using an England base will effectively mimic the overall ranking of neighbourhoods with regard to the worklessness rate.

2.1 The transition platform

On this basis, and for the base year (2001), all 32,482 English LSOAs are ranked according to the ratio of their worklessness rates with host LAD values and grouped into 20 bandings each of which corresponds to 5 percentile points on the overall distribution. The same approach is adopted for 2006 with the important difference that the banding thresholds used to segment the distribution remain fixed at the 2001 ratio values.

This approach constructs a 20 by 20 transition (or origin/destination) matrix showing the extent to which LSOAs remain in their original band or move to higher or lower bands between 2001 and 2006.

2 Modelling transition probabilities across space is becoming more common in many research arenas including voting, behaviour, land-use, urban development and ecology.
3 Lower Layer Super Output Area.

Table 2.1 illustrates the basic matrix structure. LSOAs in the principal diagonal cells (coloured black) are LSOAs that remain in the same band in both 2001 and 2006. LSOAs in cells to the right of the principal diagonal are those that improved. LSOAs in cells to the left of the principal diagonal are those that worsened.

Table 2.1: Transition Platform

Worklessness ratio 2001	Worklesness ratio 2006											
	1	2	3	4	5	6	7	8	9	10	…	20
1		⇒	⇒	⇒	⇒	⇒	⇒					
2	⇐		⇒	⇒	⇒	⇒	⇒					
3	⇐	⇐		⇒	⇒	⇒	⇒					
4	⇐	⇐	⇐		⇒	⇒	⇒					
5												
6												
….												
20												

Bandings are defined such that band 1 includes the largest positive ratios. These are LSOA areas with much higher claimant levels than their relative LAD. Band 20 includes the smallest ratios. It is important to note that lower bands may include LSOAs that are not necessarily among the highest workless areas in absolute terms – it is their position relative to the host LAD that defines banding.

Figure 2.1: Non-Transition LSOAs: 2001/06

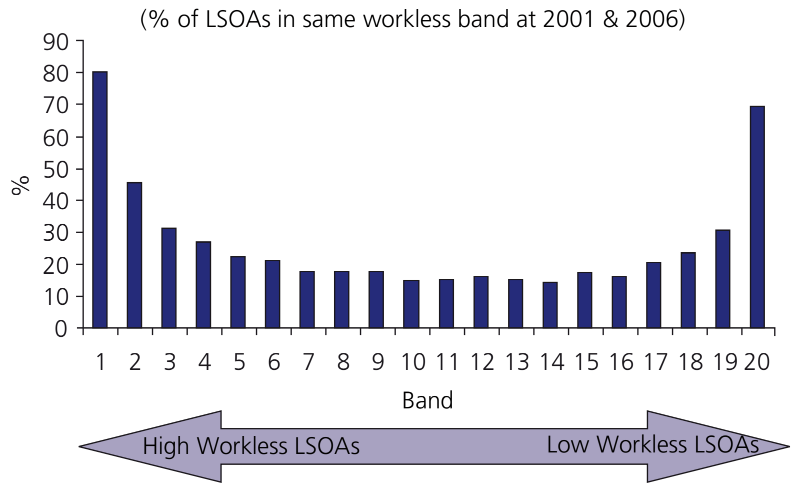


Figure 2.2: Band Improver Profile: 2001/06

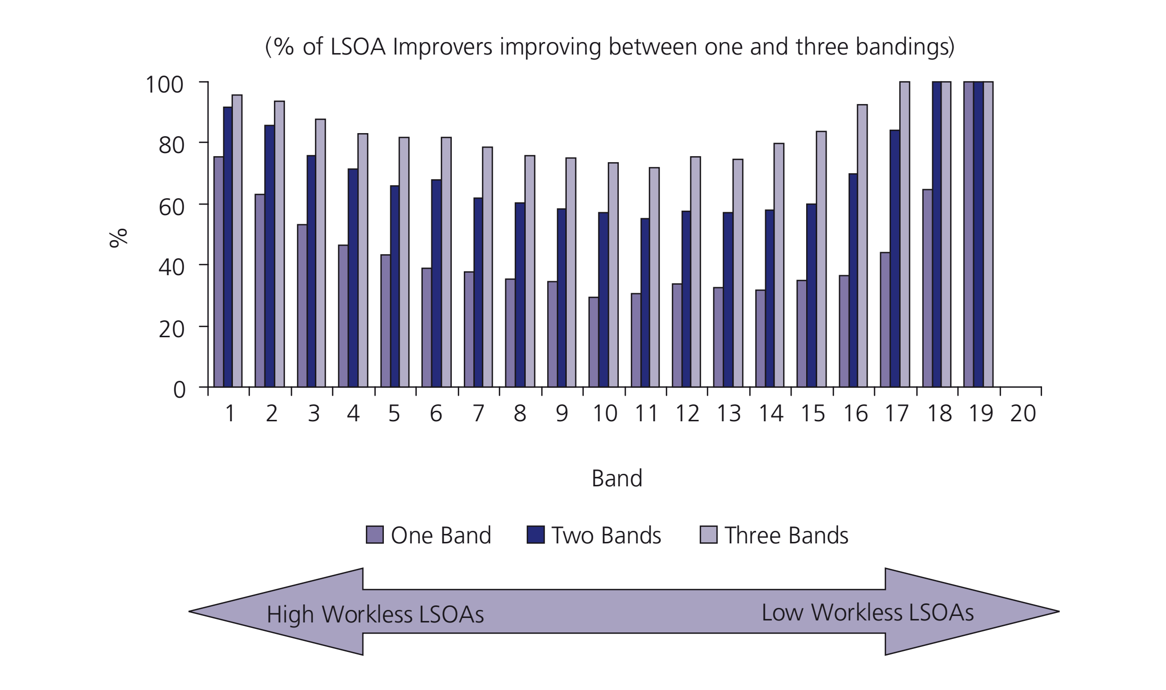


Figure 2.3: Band Decliner Profile: 2001/06

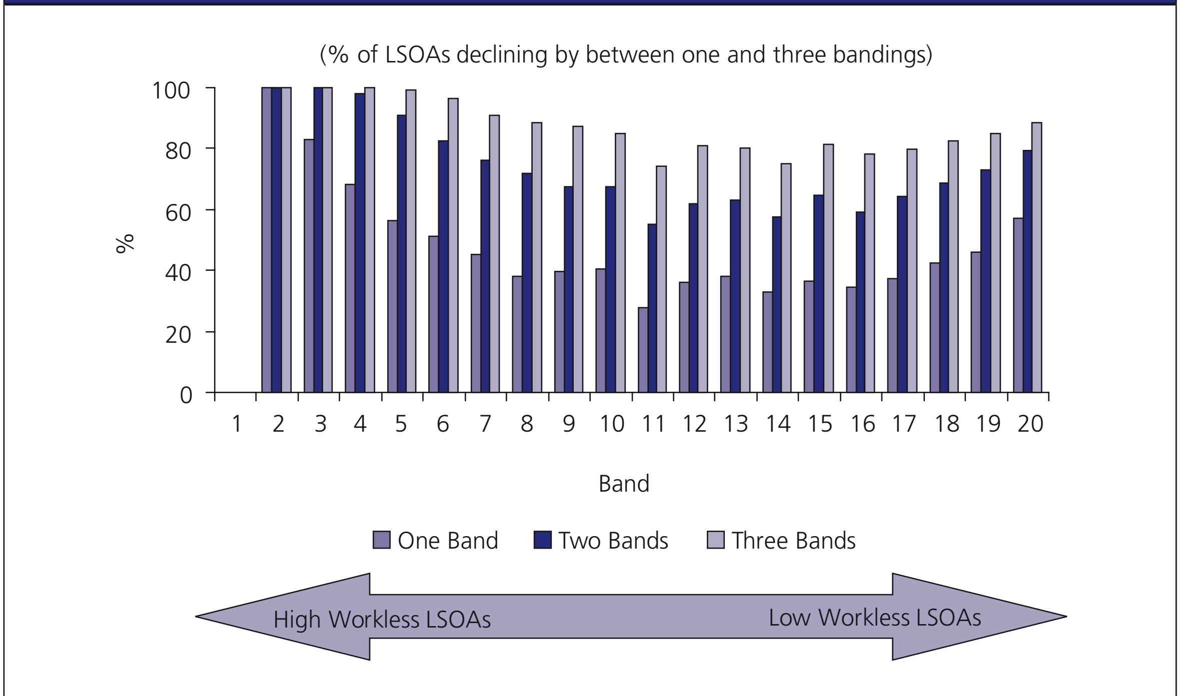
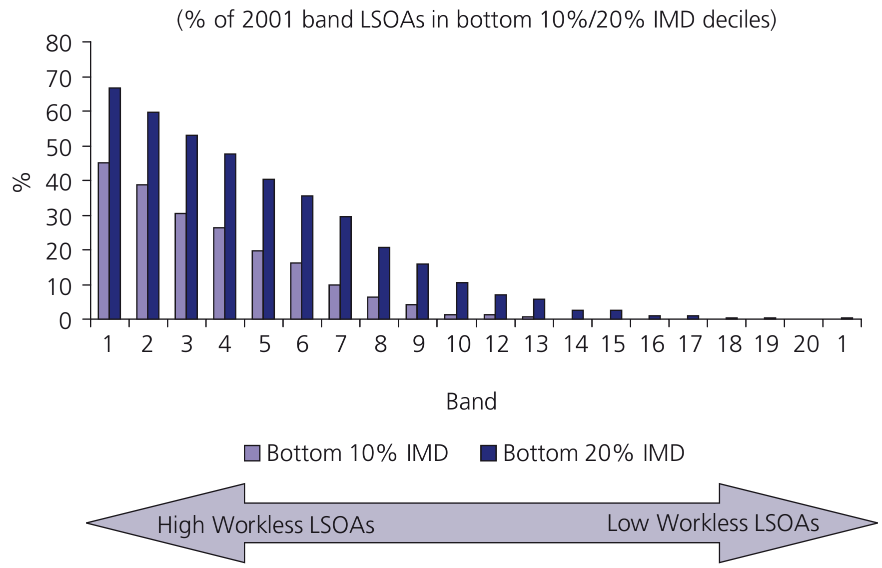


Figure 2.4: Band IMD Composition: 2001



Figures 2.1 to 2.4 provide some background as to the basic matrix content. Figure 2.1 shows the proportion of LSOAs in each 2001 band that remain in the same band in 2006. It is clear that transitions are much more extensive in the middle than at the extremes of the distribution where some 70 per cent to 80 per cent of LSOAs maintain the same standing across the period.

Figures 2.2 and 2.3 provide some detail on the scale of transition within each starting band for both improvers and decliners. Figure 2.2 shows the extent of movement across bands by improvers. Of improvers initially located in band 1, 75 per cent improve by one band, 92 per cent improve by either one or two bands and 96 per cent improve by either, one two or three bands. Likewise, Figure 2.3 shows the extent of movement across bands by decliners.[4]

In terms of the former, movement is again more limited at the ends of the distribution – no figure is reported for band 20 as no improvement is feasible – around 60 per cent of improvers tend to move just one band. This figure drops to 30 per cent in the middle of the distribution where moves of up to two bands are more evident. A broadly similar picture is evident in terms of decliners.

Figure 2.4, finally, indicates the proportion of LSOAs in each band that are also defined as lying in the bottom 10 per cent and 20 per cent of the 2001 IMD distribution. As anticipated, the presence of such areas is much more pronounced in the lower bands though the general mix of area types in the bands, and their profiling across the whole of England, is also likely to help limiting spatial autocorrelation.[5]

4 Naturally, any value of 100% for a single band move must also be 100% for a two and three band movement range.
5 Spatial correlation exists when the presence of some quantity in an area makes its presence in neighbouring areas more or less likely. It can lead to misinterpretation of findings if not taken into account.

Constructing the matrix in this way facilitates a probability-based approach to modelling transition whereby a binary dependent variable reflecting an LSOA that moves upwards or downwards across bands is assigned a unit value and a zero otherwise. The matrix thereby provides a vast range of potential binary structures for analysis.

2.2 Area improvement and decline

In this paper, modelling concentrates on two particular types of transition. The first set of transitions reflects the probability of improvement among LSOAs defined to be within the bottom 4 bands in 2001 (i.e. those in the bottom 20 per cent in the distribution).

Starting with LSOAs in the lowest band, the analysis broadens to include improvement from either the first and second bands, the first, second and thirds bands and finally each of the lowest four bands. In other words (and as shown in Table 2.2):

- Model 1: LSOAs originating in Band 1 in 2001 with transition to Band 2+ in 2006
- Model 2: Model 1 plus LSOAs originating in Band 2 in 2001 with transition to Band 3+ in 2006
- Model 3: Model 2 plus LSOAs originating in Band 3 in 2001 with transition to Band 4+ in 2006
- Model 4: Model 3 plus LSOAs originating in Band 4 in 2001 with transition to Band 5+ in 2006.

Table 2.2: Improver Base

	Worklesness ratio 2006											
Worklesness ratio 2001	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**…**	**20**
1	X1	⇒	⇒	⇒								
2		+X2	⇒	⇒	⇒							
3			+X3	⇒	⇒	⇒						
4				+X4	⇒	⇒	⇒					
5												
6												
…												
20												

The second set of transitions focus on the probability of a deterioration into the bottom 5 per cent or 10 per cent of LSOAs in 2006 from 'better' band positions in 2001. In the case of the bottom 5 per cent band this covers (Table 2.3):

- Model 5: LSOAs defined as in Band 1 in 2006 with transition from a Band 2 position in 2001
- Model 6: Model 5 plus LSOAs defined as in Band 1 in 2006 with transition from a Band 2 or 3 position in 2001
- Model 7: Model 6 plus LSOAs defined as in Band 1 in 2006 with transition from a Band 2, 3 or 4 position in 2001
- Model 8: Model 7 plus LSOAs defined as in Band 1 in 2006 with transition from a Band 2, 3, 4 or 5 position in 2001.

A similar set of analysis is also undertaken in Table 2.3 for the probability of decline into the bottom 10 per cent of the distribution. These define models 9 to 12.

Table 2.3: Decliner Base

	Worklessness ratio 2006											
Worklessness ratio 2001	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**…**	**20**
1	*X1*	*X1*										
2	⇑	*X2*										
3	⇑	⇑										
4	⇑	⇑										
5	⇑	⇑										
6		⇑										
…												
20												

3 Explaining transition

The objective of the modelling is to investigate the range of factors that help to explain the data patterns within the matrices defined in section 2. A range of datasets have been assembled to examine the process of transition. The process is invariably constrained by the fact that modelling is focussed at LSOA level and the range of datasets, while growing, is still relatively limited at this spatial level. Indeed, in many instances it is necessary to employ data extracted from the 2001 Census though on this occasion such datasets coincide with the base date of the transition analysis.

3.1 Spatial controls

Each of the models employs a series of spatial controls at two levels of geography. In the first instance, controls are included for the Government Office (GO) regions of England. In addition, area-type controls are included to allow for differing functional roles and are measured at Local Authority District (LAD) level. These have been defined by the Centre for Urban Policy Studies (CUPS) at the University of Manchester and include controls for:

- London Conurbations
- London Dormitories
- Conurbation Core
- Conurbation Industrial
- Non-London Dormitories
- Large Free Standing Cities
- Large Free Standing Towns
- Industrial & Mining
- Seaside
- Rural areas.

3.2 Length of residence and tenure

The potential role of resident 'churn' in contributing to transition is assessed via a length of residence variable detailing the proportion of the resident population residing in each LSOA across four categories:

- less than 1 year
- 1 to 3 years

- 4 to 10 years
- 11+ years.

These data have been supplied by Experian.

Tenure profile is defined in terms of the proportion of residents living in rented public sector, rented private sector and owner occupied properties and extracted from the 2001 Census.

3.3 Ethnicity

Ethnic mix is reflected in a series of variables detailing the proportion of area residents defined as being of:

- White
- Black Caribbean
- Black African
- Indian
- Pakistani
- Bangladeshi
- Chinese
- Other mixed origins.

As at the 2001 Census.

3.4 Age profiles

The age distribution of each area is assessed through two Census variables:

- the young working age (15–24)
- the adult working age (25–64).

3.5 Skills profiles

Skills are profiled by Census variables reflecting proportions of residents having achieved various NVQ qualifications or equivalents:

- below level 1 skills, levels 1 or 2 skills
- levels 3 or 4 skills.

3.6 GVA performance

The model investigates whether transition can be linked to broader economic processes by including a GVA performance variable. This assigns LSOAs to one of three binary variables:

- high GVA growth areas
- moderate GVA growth areas
- low GVA growth areas.

3.7 LAD performance

Since LSOA transition is assessed relative to its LAD host, an allowance is made to account for the potential that the host LAD may itself have altered its workless position relative to that of the overall England average. A simple binary structure is adopted reflecting the status of the host LAD relative to the latter over the study period.

3.8 Access to low skilled jobs

Accessibility to lower skilled jobs may play a role in encouraging benefit claimants to secure employment. This potential is investigated through construction of indices estimating the proportion of low skilled jobs (NVQ Level 2 or lower) within specified distances from the centroids of each LSOA. Distance is calculated on a crow-fly basis with the initial thresholds set at 5km and 20km.

3.9 Other domain performance

Along with LSOA level data on worklessness, SDRC have provided LSOA datasets on health status, crime, housing and education. These are included in the datasets via a binary structure defining high or low performance.

3.10 Bottom 10%/20% IMD performance

Since transition bandings are defined on a relative basis (to host LADs), the modelling process examines the extent to which transition is influenced by more general deprivation status. The latter is represented by binary variables indicating whether an LSOA is defined to be within the bottom, or second bottom deciles of the 2001 IMD profile.

3.11 Policy areas

The final variable set included is intended to represent the two primary area based initiatives in place over the study period, namely the New Deal for Communities (NDC) and Neighbourhood Renewal Fund (NRF). There are a number of issues that underlie these variables including the fact that while target NDC LSOAs are fully specified, the nature of the NRF programme has been such that limited comparable targeting took place at LSOA level and there are also areas of policy overlap (LSOAs receiving both NDC and NRF funding). The NSNR Evaluation team have undertaken an exercise that allows the definition of LSOAs receiving NRF spend for some local authorities, but not all. As such, the variable structure employed is defined as follows:

- given the larger spend within NDC areas, LSOAs receiving both NDC and NRF funds are designated as NDC policy areas
- other LSOAs identified as in receipt of NRF funds through the Amion exercise are defined as NRF targeted areas
- other LSOAs in a NRF authority, but where the pattern spend cannot be identified are defined as non-targeted NRF areas
- all other areas defined as 'non-policy areas'.[6]

The modelling undertaken in later sections of the paper seeks to examine the extent to which the likelihood of transition across bands, discussed earlier, can be related to variation in the datasets described above.

6 It is recognised that many more area-based initiatives were running during the study period and just prior to it, but definition is an intensive process and is not addressed in this paper.

4 Modelling area transitions

4.1 The logit model

Event outcomes that can be viewed as binary in nature (taking a value of either 1 or 0) can be assessed in the context of a framework of probability models whereby:

$$\text{Prob(event j occurs)} = P(Y = j) = F(\underline{X}) = \beta_i X_i \qquad (4.1)$$

In other words, the probability of event j occurring ($P(Y = j)$) can be seen as a function (F) of a series (or more accurately a vector) of independent variables ($\underline{X}$) with individual variables (X_i) impacting through a related set of parameters (β_i).

The key characteristic of a probability is that it must, by definition, lie between the values of 0 and 1. Hence, any model employed to model binary outcomes must constrain predicted outcomes to the [0,1] range and it is this requirement that undermines the application of Ordinary Least Squares (OLS) to binary models.

While there is no technical barrier to using OLS to estimate probabilities, neither is there anything to constrain predicted probabilities to the [0,1] range. As pointed out by Greene (2000),[7] modelling binary outcomes requires that:

$$\text{Lim } P(Y = 1) = 1 \text{ as } F(\underline{X}) \text{ approaches } +\infty$$

$$\text{Lim } P(Y = 1) = 0 \text{ as } F(\underline{X}) \text{ approaches } -\infty$$

This requirement is fulfilled by applying a transformation based on any of a number of continuous (probability) distribution functions (CDFs).[8] One very common CDF, widely used due to mathematical convenience, is the logistic distribution.

$$P(Y = 1) = e^{\beta i X i} / (1 + e^{\beta i X i}) \qquad (4.2)$$

Reorganising terms shows that $e^{\beta i X i} = P/(1 - P)$ so that taking logarithms of both sides links the log of the odds ratio $[P/(1 - P)]$ directly to the set of independent variables. Most binary models are estimated using maximum likelihood methods[9] and in this case are estimated via STATA.

7 Greene, W. (2000) *Econometric Analysis.* Prentice Hall.
8 CDFs, by their very nature, have a range in the unit [0,1] interval.
9 Determining the parameters that maximize the probability (likelihood) of the sample data.

4.2 Performance and diagnostic criteria

Individual parameter significance is assessed after adjusting for robust (Huber and White)[10] estimates of variance and all continuous variables are modelled as deviations from their means to reduce collinearity.[11]

Tests for collinearity are implemented through examination of both tolerance and variance inflation factor (VIF) indicators. The tolerance for a particular variable is 1 minus the R^2 that results from the regression of that variable on the other variables, while the corresponding VIF is 1/tolerance.

If all variables in a model are orthogonal, both the tolerance and VIF are 1. If a variable is very closely related to other variables, tolerance goes to 0, and the variance inflation increases in size. The current rule of thumb is that a tolerance of 0.1 or less (equivalent to a VIF of 10 or greater) is likely to present a cause for concern.

Assessing Goodness of fit (GOF) in binary models is not straightforward. Part of the reason stems from use of maximum likelihood methods – unlike OLS where 'fit' (and thereby definition of parameters) is optimised in terms of maximising predictive performance, ML is optimised to maximise the joint density of the actual dependent variable.

Substantial discussion of GOF for binary models exists in econometric, biometric and statistical literature. Since such models are estimated by ML methods, it is commonplace to use simple chi-square likelihood ratio (LR) tests for joint significance of estimated parameters. This computes log-likelihoods for a fully specified model $L(M_F)$ and an alternative with all parameters but the intercept set to zero $L(M_0)$. The test statistic is defined as[12] $LR = 2 \ln L(M_F) – 2 \ln L(M_0)$.

Despite widespread use of the LR test, it is increasingly recognised that when sample sizes are large, adding terms will generally tend to improve fit. Consequently, it becomes more difficult to distinguish real as opposed to trivial improvements and models can be less parsimonious than might otherwise be the case.

There also exists some difference of opinion about other GOF measures. Given the widespread use of OLS, it is natural that some attention has been paid to the development of scalar GOF measures. Long and Freese (2000) provide a review of such measures noting the attraction of what they call 'Pseudo-R^2' approaches – measures that attempt to parallel the value and simplicity of the traditional R^2 statistic.[13] By far the most common of these is McFadden's R^2, otherwise known as the likelihood ratio index and reported within STATA as 'Pseudo-R^2'.

[10] White, H. (1980) A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica*, 48(4), pp. 817–38. Huber, P. J. (1967). The behaviour of maximum likelihood estimates under nonstandard conditions. In: *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability*. Berkeley, CA: University of California Press, vol.1, pp. 221–33.
[11] The models are also tested for, but do not identify the presence of, omitted variable or specification bias.
[12] The negative of the first term in the, $–2 \ln L(M_F)$, is also known as the deviance and compares a given model to a model that has one parameter for each observation and can thus perfectly reproduce the observed data.
[13] Long, J.S. and Freese, J. (2000) Scalar Measures of Fit for Regression Models. *STATA Technical Bulletin*, Volume 10.

This is constructed as $1 - [\ln \hat{L}(M_F) / \ln \hat{L}(M_0)]$ and while it can equal 0, it can never exactly equal 1. Other alternatives include:

- the maximum likelihood R^2 defined as $1 - [L(M0) / L(M_F)]^{2/N}$ often attributed to Maddala (referred to as the Cox-Snell R^2 within SPSS) and which has a maximum of $1 - L(M_0)^{2/N}$
- Cragg and Uhler's R^2 defined as $[1 - [L(M_0) / L(M_F)]^{2/N}] / 1 - L(M_0)^{2/N}$ which allows the measure to reach a unit value (referred to as the Nagelkerke R^2 in SPSS)
- Effrons R^2 defined as $1 - [\sum(y_i - \hat{\pi})^2 / \sum(y_i - \bar{y})^2]$ where $\hat{\pi}$ indicates predicted probabilities
- McKelvey & Zavoina's R2 defined as $V\hat{a}r\ (\hat{y}^*) / [V\hat{a}r\ (\hat{y}^*) + Var\ (\varepsilon)]$ where y* is a latent variable $y^* = \beta\underline{X} + \varepsilon$

In addition, there has been something of a tendency to consider what is known as the count r^2 measure (the proportion of binary outcomes predicted correctly) taking into account both sensitivity (proportion of positive outcomes correctly classified as positive) and specificity (proportion of negative outcomes correctly classified as negative).

Attention has also been paid to the use of 'information' measures whereby focus is on assessing the relative plausibility of different model specifications rather than deviation of observed data from a specific model. The most common measures applied include:

- Akaike's Information Criteria (AIC) defined as $[-2 \ln \hat{L}(M_k) + 2P]/N$ where $\hat{L}(Mk)$ is the likelihood of the model, k is the number of regressors and P is the number of parameters in the model. Ceteris paribus, models with smaller AIC values fit better
- Bayesian Information Criterion (BIC) defined as $D(M_k) - df_k \ln (N)$ where $D(\cdot)$ is the model deviance and df_k is the degrees of freedom associated with the deviance. Again better fit equates to more negative values.

Hosmer & Lemeshow (2000), in writing what has now become something of a reference text in applied logistic regression, consider the issue of GOF in some detail and take a very different set of perspectives.[14] In the first instance, they strongly suggest limiting use of R^2 type measures to model building only and not final reporting. As they point out in terms of the examples discussed in the text:

"All of the various R^2 values … are low when compared to R^2 values typically encountered with good linear regression models. Unfortunately low R^2 values in logistic regression are the norm and this presents a problem when reporting their values to an audience accustomed to seeing linear regression values … Thus we do not recommend routine publishing of R^2 values with results from fitted logistic regression models. However, they may be helpful in the model building stage as a statistic to evaluate competing models".[15]

[14] Hosmer, D.W. and Lemeshow, S. (2000) *Applied Logistic Regression*. Wiley.
[15] ibid. Chapter 5.

Likewise, Hosmer & Lemeshow advise against the use of classification tables such as those employed in the count R^2 measure. Classification of correct positives/negatives requires that a cut-off or threshold be specified to guide assessment of success/failure – normally the value chosen is 0.5. They show that classification is sensitive to the relative sizes of the groups involved, "always favour(s) classification into the larger group" and "should not be used as measures of model performance".[16]

As alternatives, Hosmer & Lemeshow propose two other statistics. One, now known as the H&L (group) test, is based on their own earlier work.[17] The test works by ordering observations on the predicted probabilities produced by a model, forming 10 equal size groups and computing a chi-square test that reflects performance across the 10 groups. This test is now widely used in the application of logit analysis though, as ever, circumstances have been identified where application of the test requires care.[18]

The second proposal is based on use of the Receiver Operating Characteristic (ROC) curve. The curve has its origins in signal detection theory and shows how a receiver 'operates' or identifies the existence of a signal in the presence of noise, plotting the probability of detecting the true signal (sensitivity) and false signal (1 – specificity) for a wide range of cut-off points. The area under the ROC curve (ranging from 0 to 1) in terms of logit applications, provides a measure of a model's ability to discriminate between positive and non-positive outcomes.[19]

Hosmer & Lemeshow also spend some time reviewing mechanisms for testing leverage or influence – the extent to which parameter values or GOF measures are influenced by individual observations. One of the more prominent mechanisms employed is the Pregibon dbeta measure which tests for change in the coefficient vector caused by deleting an observation.[20] They suggest that models be assessed in terms of such a statistic as part of normal diagnostic considerations.

Given the range of differing perspectives reported, we assess a number of GOF measures including the Cragg-Uhler R^2 measure, the H&L (group) test and the ROC statistic along with the Pregibon dbeta diagnostic statistic.

In addition to measures of performance, attention is paid to the issue of spatial dependence. In particular, all of the models are tested in terms of the spatial GMM structures for logit modelling developed by Conley (1999) and amended by Vigfusson (1999). The adjustments are broadly similar to those in standard heteroscedasticity and autocorrelation consistent (HAC)

16 Hosmer, D.W. and Lemeshow, S. (2000) *Applied Logistic Regression*. Wiley. Chapter 5.
17 Hosmer D.W. and Lemeshow, S. (1980) A goodness-of-fit test for the multiple logistic regression model. *Communications in Statistics*, Vol. 10, pp. 1043–1069.
18 See for example, Bertolini et al. (2000)One model, several results: the paradox of the Hosmer-Lemeshow goodness-of-fit test for the logistic regression. *Journal of Epidemiology and Biostatistics*, Vol. 5, pp. 251–253 and Hosmer et al. (1997) A comparison of goodness-of-fit tests for the logistic regression model. *Statistics in Medicine*, Vol. 16, pp. 965–980.
19 The guidance provided suggests that ROC values between 0.7 and 0.8 deliver acceptable discrimination, values between 0.8 and 0.9 deliver excellent discrimination and values above 0.9 deliver outstanding discrimination. It is pointed out that values above 0.9 should be considered extremely unusual.
20 Pregibon D. (1981) Logistic Regression Diagnostics. *Annals of Statistics*, Vol. 9, pp. 705–724.

frameworks in that it is required to specify a maximum lag in the disturbance process.

4.3 Model profiles

Twelve models are tested in total, corresponding to the range of options discussed in section 2.2. STATA outputs allow for 'robust' standard error estimation having removed outliers as indicated by the Pregibon dbeta measure.

Evidence suggests that collinearity is relatively mild with few if any variables indicated to be problematic in terms of VIF criteria, regardless of model structure.[21] Likewise, evidence of spatial dependence is moderate – spatially adjusted (parameter) standard errors differ from the 'standard' errors reported, but are relatively similar to the robust standard errors indicated. This may well reflect the construction of the transition bands noted earlier.

In terms of broader performance statistics, Table 4.1 provides a summary of the Hosmer & Lemeshow GOF(10) statistics, the Cragg & Uhler R^2 and the ROC statistic along with the sample size of each model (N).

All of the models pass the H&L criterion with some measure of comfort (Model 11 is the poorest performing model in this context). The Cragg & Uhler R^2 profile is provided as it is one of the few pseudo R^2 measures that has a unit range but the warnings of Hosmer & Lemeshow with regards to interpretation of such figures suggest that it should be given less regard than other measures. The ROC statistics all meet the 'acceptable' threshold with a number (those approaching 0.8) defined as being on the margins of 'excellent discrimination'.

Table 4.1: Model Performance Characteristics

Model	N	H&L GOF(10)	Cragg & Uhler R^2	ROC
1	1613	0.3598	0.272	0.7923
2	3248	0.4893	0.215	0.7559
3	4872	0.5405	0.202	0.7418
4	6496	0.6479	0.190	0.7286
5	1610	0.7985	0.157	0.7134
6	3244	0.7051	0.172	0.7470
7	4869	0.8912	0.187	0.7750
8	6493	0.4825	0.212	0.8034
9	1624	0.2492	0.178	0.7221
10	3248	0.3620	0.154	0.7233
11	4873	0.1065	0.166	0.7436
12	6496	0.2744	0.182	0.7672

[21] Collinearity occurs when variables display very similar patterns and makes it difficult to interpret statistical significance.

Overall, the performance profiles are judged to deliver a moderately robust representation of activity across the transition bandings and Table 4.2 provides a simple summary of the statistical significance and direction of each variable across all 12 models. Each cell contains either no entry – indicating no significance – or an entry detailing the level of significance of the variable (10%, 5%, 1%) and the associated sign.

Summary of results

Spatial controls

The only spatial controls identified as significant relate to the London, Eastern and Yorkshire and The Humber regions. Although not consistent across all models, the results suggest there has been a tendency for London LSOAs to improve more and deteriorate less, even allowing for the other variables modelled, than other regions.

Similar findings are evident for the Eastern region though the pattern of lower decline is more notable in the 10 per cent rather than the 5 per cent models. Yorkshire and The Humber LSOAs are identified as having been more likely to decline into the more polarised bandings in both 'decline' models with no corresponding improver upside.

As for the LAD level controls, consistent and significant relative improvement effects are evident in London conurbations, other conurbation cores, industrial conurbations and Large Freestanding cities. Likewise, the decliner (5%) model shows consistent and significant negative effects in London conurbations, conurbation cores and non-London dormitories along with some suggestion of similar patterns in Large Freestanding Towns and industrial/mining LADs.

Finally, the decline (10%) models show consistent and significant negative effects for London conurbations, conurbation cores and industrial/mining LADs, but not non-London dormitories. While there is some suggestion of a less negative seaside decline effect in the 5 per cent decline framework, the reverse is the case in the 10 per cent framework.

Length of residence and tenure

Evidence on the role of residential churn is generally mixed and not particularly consistent. While indicators are significant in some improver specifications, they are inconsistent in sign. Likewise, no primary role is indicated in the decliner (10%) models though there is relatively consistent and significant indication that areas with high residential churn have been more likely to deteriorate in the decliner (5%) models.

In contrast, tenure variables are among the most significant in the entire model set with public rental and private rental variables highly significant in all model specifications. In the case of improver models, the evidence is unequivocal that higher concentrations of rental property in neighbourhoods are associated with significantly lower probability of transition. A direct

Table 4.2: Model Significance Profiles

	1	2	3	4	5	6	7	8	9	10	11	12
	Improver Models				Decliner Models (5%)				Decliner Models (10%)			
Obs	1613	3248	4872	6496	1610	3244	4869	6493	1624	3248	4872	6496
HL	0.3598	0.4893	0.5405	0.6479	0.7985	0.7051	0.8912	0.4825	0.2492	0.362	0.1065	0.2744
Region												
NE												
YH						+ve, 10%	+ve, 10%	+ve, 10%		+ve, 10%	+ve, 5%	+ve, 5%
EM												
East		+ve, 10%	+ve, 5%	+ve, 10%				–ve, 10%		–ve, 5%	–ve, 10%	–ve, 5%
Lon	+ve, 10%	+ve, 5%				–ve, 10%	–ve, 5%	–ve, 1%				
SW												
WM												
NW												
LAD Types												
Lon Con	+ve, 5%	+ve, 10%	+ve, 5%	+ve, 1%					–ve, 5%	–ve, 1%	–ve, 1%	–ve, 1%
Con Core	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 5%	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%		–ve, 5%	–ve, 5%	–ve, 1%
Con Ind	+ve, 5%	+ve, 5%	+ve, 1%	+ve, 5%	–ve, 5%	–ve, 5%	–ve, 1%	–ve, 1%				–ve, 10%
NLon Dorm									+ve, 10%			
LFS City	+ve, 10%	+ve, 5%	+ve, 1%	+ve, 5%	–ve, 5%	–ve, 5%	–ve, 5%	–ve, 5%				
LFS Town								–ve, 10%				
Ind & Min							–ve, 5%	–ve, 5%		–ve, 5%	–ve, 5%	–ve, 5%
Seaside					–ve, 10%		–ve, 10%	–ve, 10%	+ve, 5%	+ve, 10%		
Rural												

continued

Table 4.2: Model Significance Profiles

	1	2	3	4	5	6	7	8	9	10	11	12
	Improver Models				Decliner Models (5%)				Decliner Models (10%)			
Length Of Residence												
<1 Yr Res					+ve, 10%	+ve, 5%	+ve, 1%	+ve, 1%				+ve, 5%
1–3 Yr Res		+ve, 5%		+ve, 5%	–ve, 10%							
4–10 Yr Res			–ve, 5%	–ve, 5%								
Demographics												
WA Pop15/24c		+ve, 10%	+ve, 10%									
WA Pop25/64c	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 5%			+ve, 5%	+ve, 1%				
Ethnicity												
Blk Car			+ve, 10%									+ve, 5%
Blk Afr		+ve, 5%	+ve, 5%	+ve, 5%	–ve, 10%	–ve, 1%	–ve, 1%	–ve, 1%		–ve, 10%	–ve, 5%	–ve, 5%
Indian	+ve, 1%	+ve, 10%	+ve, 5%	+ve, 1%		–ve, 10%	–ve, 10%	–ve, 10%	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%
Pakistani												
Bangladeshi					–ve, 5%	–ve, 10%	–ve, 5%	–ve, 5%	+ve, 10%			
Chinese				+ve, 5%								
Other												
Skills												
Level 1/2c	+ve, 1%							–ve, 10%				
Level ¾	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%				–ve, 5%		–ve, 10%	–ve, 1%	–ve, 1%
Tenure												
Rent: Public	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%
Rent: Private	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%

continued

Table 4.2: Model Significance Profiles

	1	2	3	4	5	6	7	8	9	10	11	12
	Improver Models				Decliner Models (5%)				Decliner Models (10%)			
LAD/England												
GTGT	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	+ve, 10%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 5%	+ve, 1%	+ve, 1%	+ve, 1%
Other												
Policy												
NRF LSOA)							–ve, 5%	–ve, 5%	–ve, 10%	–ve, 1%	–ve, 1%	–ve, 1%
NDC(LSOA)				+ve, 10%			–ve, 5%	–ve, 5%		–ve, 10%	–ve, 5%	–ve, 1%
NRF (LAD)		+ve, 5%	+ve, 10%	+ve, 5%		–ve, 1%	–ve, 1%	–ve, 1%	–ve, 5%	–ve, 1%	–ve, 1%	–ve, 1%
GVA Growth												
Low Growth										+ve, 10%	+ve, 5%	+ve, 5%
High Growth	+ve, 1%	+ve, 1%	+ve, 5%	+ve, 5%		–ve, 5%	–ve, 5%	–ve, 1%				–ve, 5%
Low Skills Job Access												
Access: 5k	+ve, 5%	+ve, 10%	+ve, 5%	+ve, 10%					–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%
Access: 20k	+ve, 10%		+ve, 5%	+ve, 10%					–ve, 1%	–ve, 5%	–ve, 5%	–ve, 1%
Access: 20k	+ve, 10%		+ve, 5%	+ve, 10%					–ve, 1%	–ve, 5%	–ve, 5%	–ve, 1%
Other Domains												
High SMR	–ve, 5%	–ve, 1%	–ve, 1%	–ve, 1%		+ve, 5%	+ve, 5%	+ve, 1%		+ve, 10%	+ve, 10%	+ve, 5%
Low SMR				+ve, 10%		–ve, 10%						
High Theft						–ve, 5%	–ve, 5%	–ve, 5%				
Low Theft												
High Hse Price												
Low Hse Price	+ve, 10%								+ve, 5%	+ve, 10%	+ve, 10%	+ve, 5%
High KS2												
Low Ks2									+ve, 5%	+ve, 5%	+ve, 5%	+ve, 5%
Deprived Area												
Bot 10% IMD	–ve, 10%	–ve, 1%	–ve, 1%	–ve, 5%			+ve, 1%	+ve, 1%		+ve, 10%	+ve, 1%	+ve, 1%
Bot 10%/20% IMD		–ve, 5%	–ve, 1%	–ve, 5%			+ve, 5%	+ve, 1%		+ve, 10%	+ve, 5%	+ve, 1%

reverse, and equally strong indication, is evident in both sets of decliner models.

Ethnicity

Ethnic indicators display some variability across the models. In terms of the improver equations, areas with larger black African and Indian cohorts appear to have performed notably better than those with higher white cohorts, ceteris paribus. The decliner (5%) results mostly show the reverse picture with areas containing larger black African and Indian cohorts being less likely to have declined. There is also some suggestion that higher cohort Bangladeshi areas may also have been less likely to decline, though the profile is only weakly significant. The decliner (10%) results are also mostly the reverse of the improver picture and consistent with 5 per cent results but the Bangladeshi cohort effect is no longer present.

Skills profiles

The skills variables supply an interesting set of profiles. In terms of improvers, a strong positive role is indicated for skills at both levels 1 & 2 and levels 3 & 4 for the bottom band but it is primarily levels 3 & 4 skills that are important for other specifications in the improver set.

No role is indicated for skills in the decliner (5%) model set until the broadest equation when (an expected) negative sign is present but a stronger role for skills is evident in the 10 per cent model set though significance is again primarily limited to levels 3 & 4.

GVA performance

Alongside skills, model results provide a set of interesting results for the link between transition and GVA performance. The improver profiles indicate that there exist strong positive benefits from having being located in a strong growth area (an area of above average growth performance) with all four models displaying significant positive coefficients.

Likewise, being located in strong GVA growth areas is identified as having reduced the likelihood of decline (5% model) and is the reverse of the improver results. Interestingly, the decliner (10%) results provide a variation – it is now the low GVA growth areas that becomes significant (increasing decline) rather than the high GVA growth variable (reducing decline)

LAD performance

As indicated earlier, since LSOA transition is assessed relative to its LAD host, an allowance is made to account for the potential that the host LAD may itself have altered its workless position relative to that of the overall England average. The variables used for this purposes show that LSOAs in LADS that have higher workless rates than England in both periods are significantly less likely to have improved and LSOAs in LADS that have higher workless rates than England in both periods are significantly more likely to have deteriorated in both decliner model sets.

Access to low skilled jobs

Whether accessibility to lower skilled jobs plays a role in encouraging benefit claimants to secure employment is another consideration tested in the model. While the evidence is not as strong as for other variables, the results suggest that moderately strong benefits from proximity have been evident in the most polarised areas and that while accessibility is not indicated to play a role in the decliner (5%) models set, a strong negative role is indicated for the 10 per cent model set.

Other domain performance

Although there is an attempt to test for links between transition profiles and other domain performance, the differing nature of temporal dynamics between worklessness, health status, house prices, crime and school performance are such that there were only ever limited expectations of other domain variables proving significant.

In practice, there is little evidence of a relationship across most domains within the improver model set, though there does exist a strong negative link attributed to areas with high Standardised Mortality Ratios (SMRs). Likewise, while there is little evidence of relationship across domains in the decliner (5%) model set there is a relatively strong positive profile attributed to high SMR areas – consistent with improver area results – as well as a negative crime effect.

The most extensive other domain effects occur in the decliner (10%) models where high positive SMR area links are evident alongside a positive low price and positive low Key Stage 2 link.

Most deprived 10%/20% IMD performance

The modelling process examines the extent to which transition is influenced by more general absolute deprivation status. As far as improvers are concerned, the results suggest that LSOAs in high deprivation areas have been significantly less likely to improve than LSOAs outside the most deprived 10 per cent or 20 per cent on the Index of Multiple Deprivation 2004. The decliner models provide generally consistent evidence in the reverse direction with LSOAs in high deprivation areas significantly more likely to have deteriorated.

Policy areas

The final variable set included is intended to represent the NDC and NRF policy frameworks. While definition of these variables is outlined in the previous section and interpretation is subject to some caveats, the results suggest that little evidence of a 'policy' effect can be attributed to LSOA based activities in improver models though the (non-targeted) LAD based variable is indicated to be significant.

The LSOA based indicators are more prevalent in the decliner (5%) model set and notably more prevalent in the decliner (10%) model set though the LAD based variable also retains significance. In all instances the coefficient signs are negative suggesting that policy has been a contributory factor in limiting decline.

4.4 Summary

This section has outlined the basis on which a series of model sets have been devised and tested, corresponding to the transition platform outlined in the early part of the paper. Overall, the models appear relatively robust, meet appropriate performance criteria and are not, due to construction, unduly burdened by spatial dependence. Model outcomes produce some relatively strong and consistent outcomes:

- skills are mostly present in results but tend to operate at level 3+ with the exception of the lowest performance band
- there exists a very strong tenure role in all specifications
- GVA growth performance is particularly relevant for the most challenged LSOAs
- accessibility to local lower level skilled jobs can play a significant role in encouraging improvement or limiting decline; and
- policy variables are more prominent in limiting decline than promoting improvement.

5 Simulations

5.1 Simulation structure

Given that model performance is robust, it is feasible to use the results to undertake a range of simulations detailing variation in transition probability relative to individual variables in the models. In computing scenarios, it is important to recognise that the models include both binary and continuous variables and that this complicates simulation work.

A shorthand approach to simulations often involves computation of the marginal effects of variables within models. This involves taking the derivative of the conditional mean function with respect to each variable and while such an approach is acceptable when a variable is continuous, it is somewhat meaningless in the case of binary variables[22] and may lead to erroneous conclusions. The simulations in this section are therefore based on full specifications of models rather than on marginal effects structures.

5.2 Simulation profiling: Continuous variables

Scrutiny of the model set shows that a number of continuous variables operate on a relatively consistent basis to influence transition profiles, namely skills (though more so levels 3 and 4), tenure, and access to low skill jobs. The figures overleaf demonstrate the simulation profiles of these variables for improver models 1 to 4.

Figure 5.1 focuses on level 3 and 4 skills with simulated concentration on the horizontal axis and predicted transition on the vertical axis.[23] The profiles for (improver) models 2 to 4[24] are relatively linear upwards while that for model 1 is more curved, demonstrating lower adjustment in transition rates for any given change in skills concentration relative to other models. The fact that the simulation lines are higher as more bandings are included indicates that intermediate and higher skills are relatively more important as one considers areas where worklessness rates are less 'distant' from their local area average.

The figure on social renting (Figure 5.2) demonstrates just how extensive transition probabilities fall as the proportion of social renting increases. The fact that there is little or no difference in profiles across the four models reinforces the intensity of this effect across models. Figures 5.3 and Figure 5.4 give simulation profiles for access to low skilled jobs within 5km and 20km distances. Although different in magnitude, both show that transition profiles for the most deprived areas (model 1) are more responsive than broader area cohorts.

22 Greene, W. (2000) *Econometric Analysis.* Prentice Hall.
23 All other figures adopt this convention.
24 See Section 2.2

Figure 5.1: Level 3&4 Skills

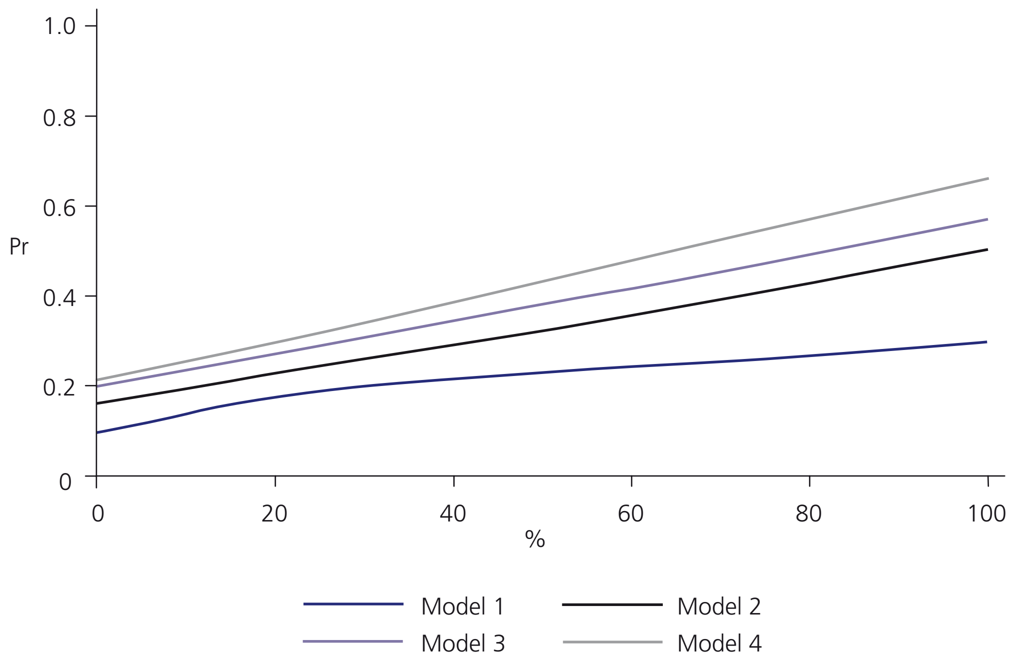
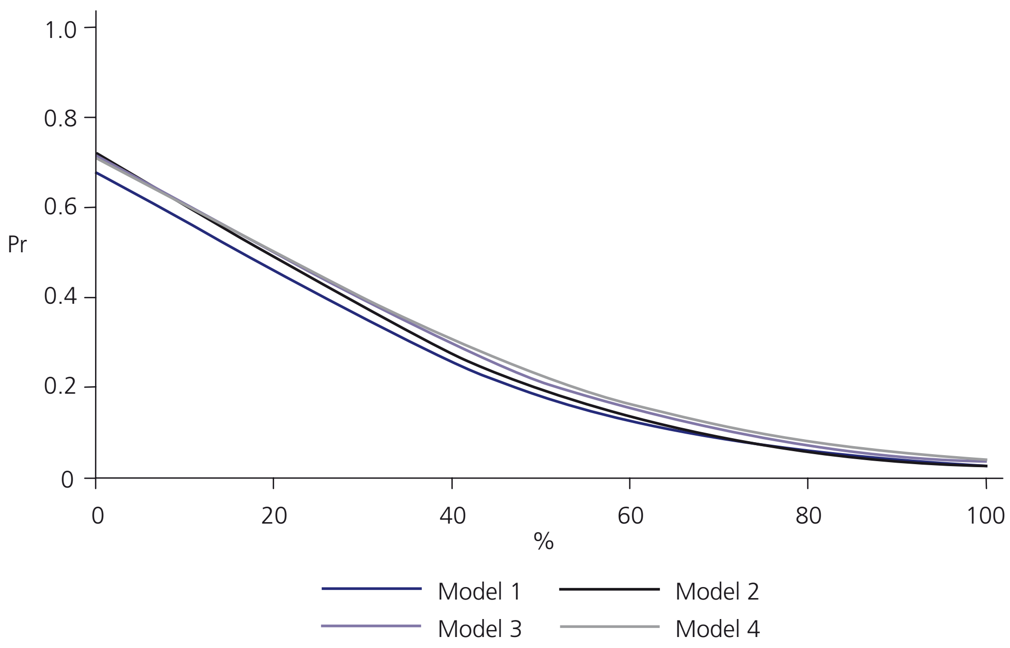


Figure 5.2: Social Renting



It is also instructive to draw direct contrast between the different variable profiles. Figure 5.5 plots comparative simulation profiles for model 1. This includes level 1 & 2 skills which is significant in model 1 for improvers (but not models 2 to 4) along with level 3 & 4 skills, social renting and access to low skilled jobs at 5km distance.

Figure 5.3: Low Skill Jobs Access (5k)

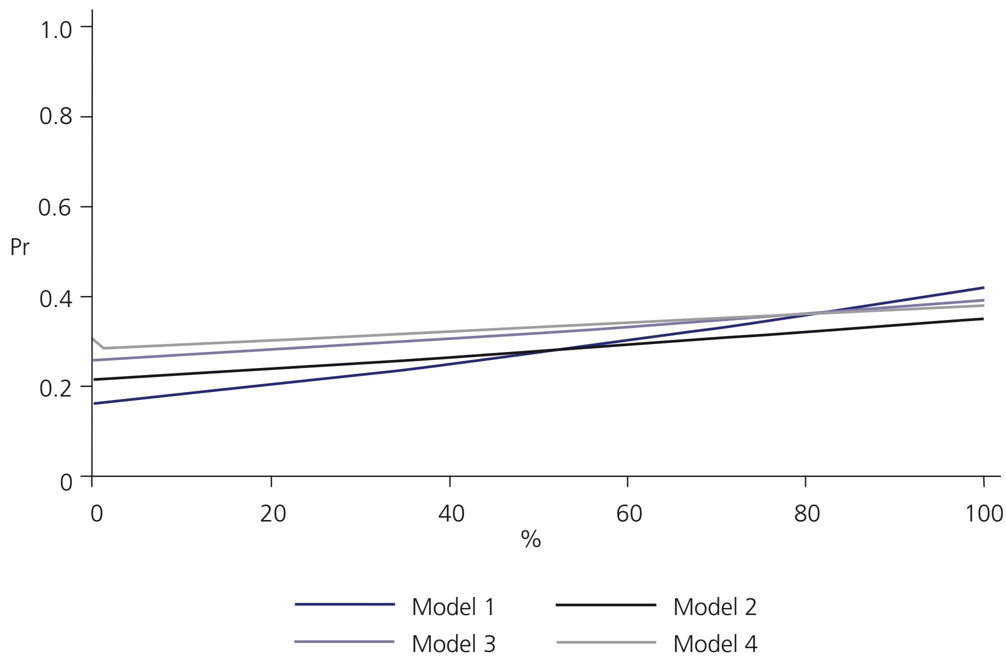
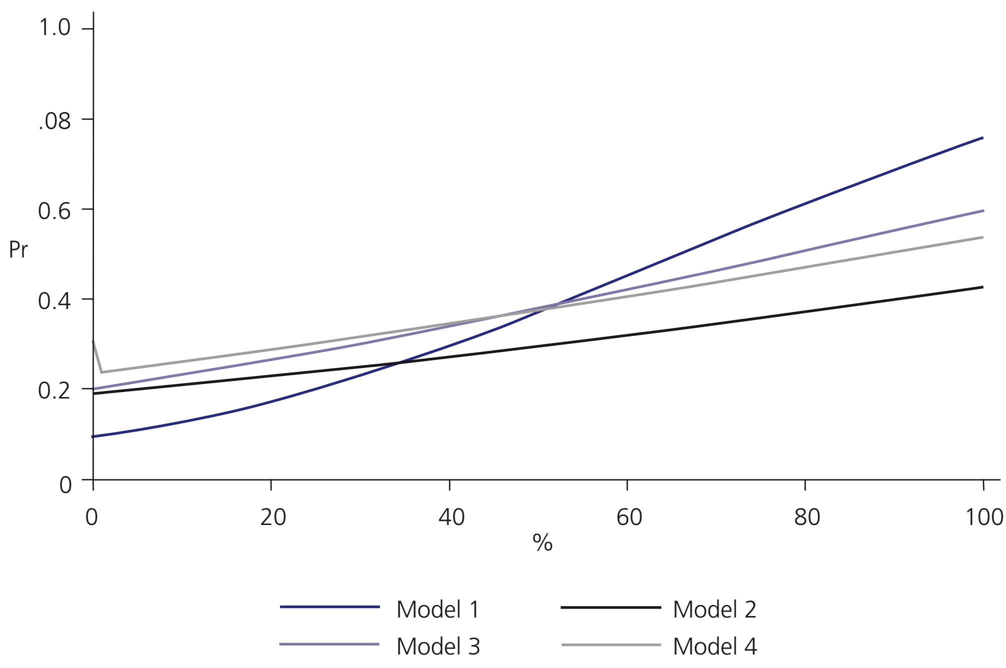


Figure 5.4: Low Skill Jobs Access (20k)



The position of the profiles confirms the importance of level 1 & 2 skills in model 1 though inspection indicates that level 3 & 4 skills are more important for transition probabilities at low to moderate levels of concentration. It is also evident that access to low skilled jobs is as important as level 3 & 4 skills for this cohort of areas.

Figure 5.6 repeats the plot for model 4 but replaces level 1 & 2 skills with the 20km access to low skills variable. This block illustrates that level 3 & 4 are significantly more important than for model 1. Likewise, access to low skilled jobs at 20k is indicated to be more significant than that at 5km. This may reflect widening access to private transport as the number of bandings increases.

Figure 5.5: Improver Model 1 Simulations

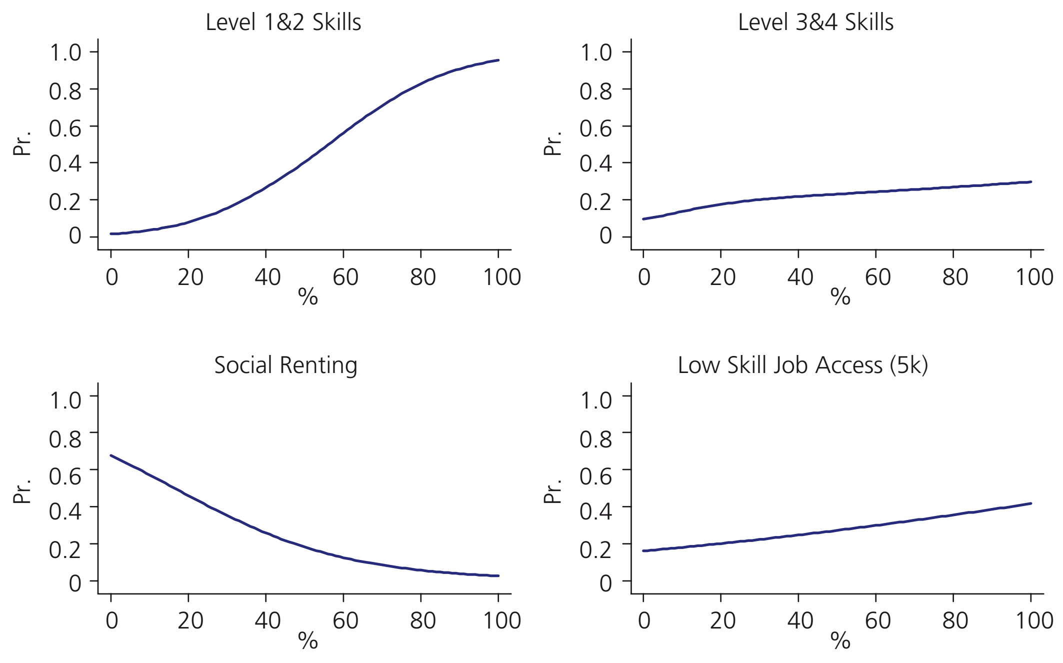
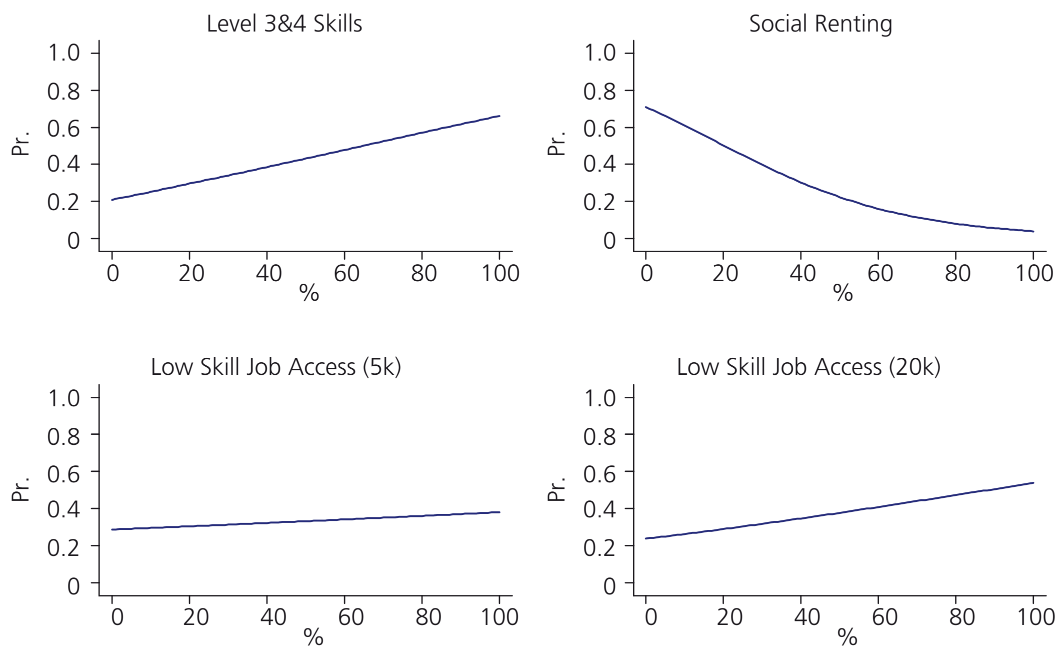


Figure 5.6: Improver Model 4 Simulations



5.3 Simulation profiling: Continuous & discrete variables

Many variables in the models are binary in nature with areas defined as being either subject to a specific set of circumstances or not, for example being in the most deprived 10 per cent IMD area or not, being in a high GVA area or not or being in a conurbation core or not. These variables can be added to the continuous variables to generate combined transition probability simulations as illustrated in the following three diagrams.

Figure 5.7: Improver Model 1 Simulations

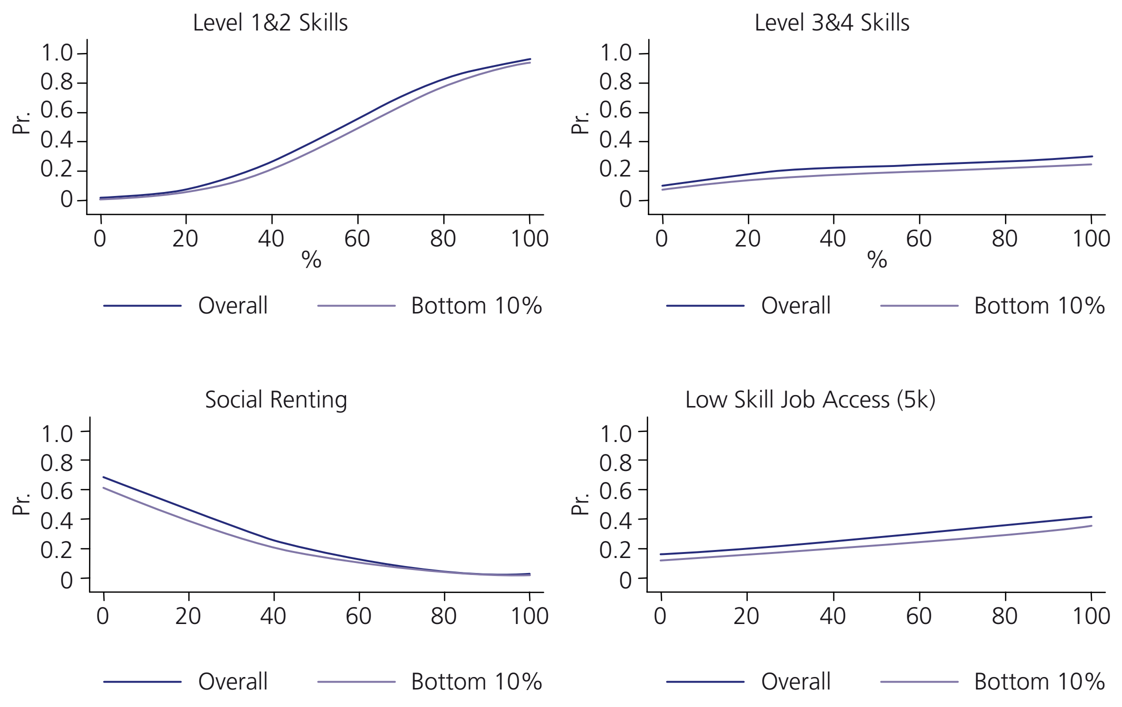


Figure 5.7 repeats Figure 5.5 but introduces secondary simulations for transition probability profiles if LSOAs are in the bottom 10 per cent IMD decile. The results show, as expected, that probabilities of improvement are reduced for most if not all values of the continuous variables.

In contrast, being located in a high GVA growth area (illustrated in Figure 5.8) has completely the reverse effect with probabilities of improvement raised for all values of the continuous variables.

The final figure – Figure 5.9 – simulates profiles for LSOAs located in a Conurbation Core area. This not only illustrates model findings that bottom band LSOAs in such areas have performed better, but indicates that they have performed better by some margin – controlling for other factors in the model.

Figure 5.8: Improver Model 4 Simulations

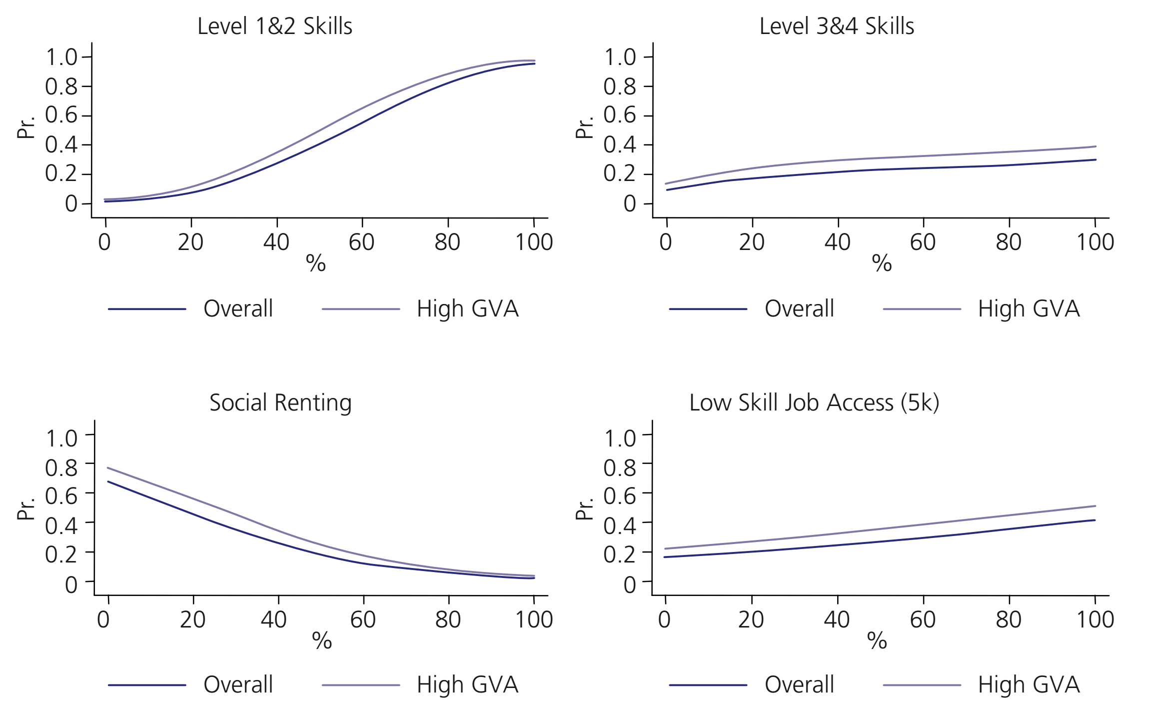
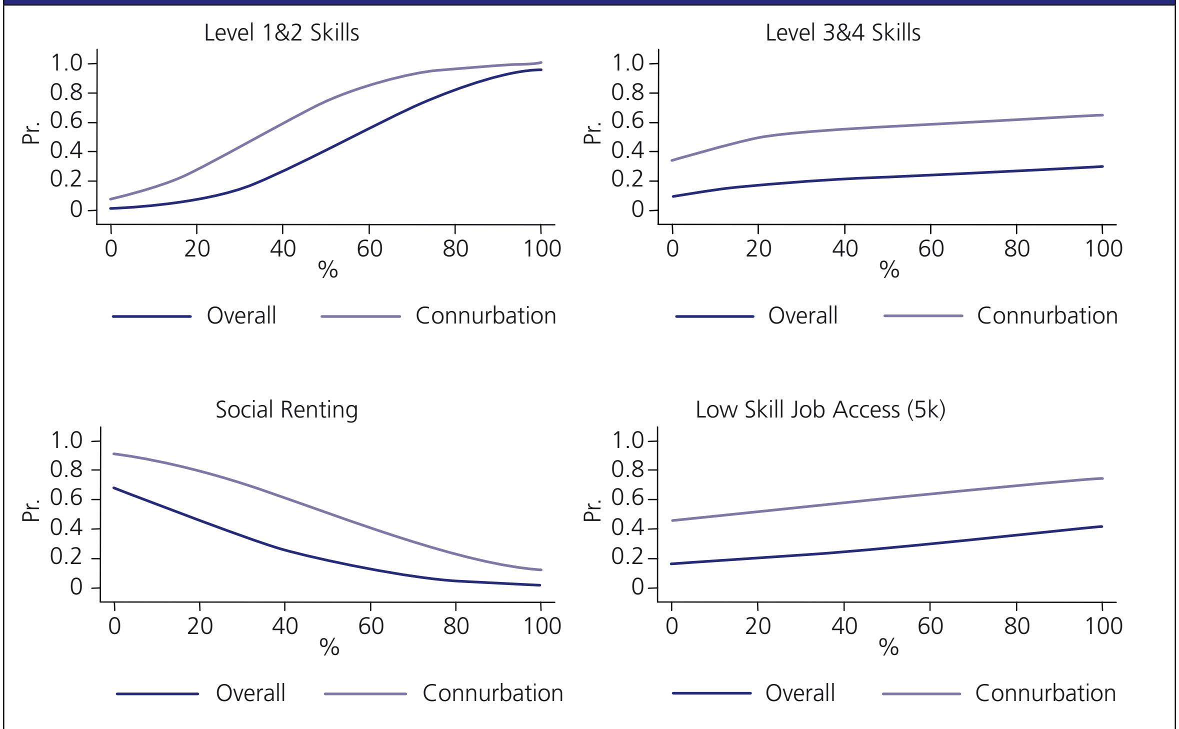


Figure 5.9: Improver Model 1 Simulations



5.4 Simulation profiling: Range & scale

Some care is required in drafting simulation structures. The illustrations in section 5.3 are evaluated over the full ‘theoretical’ range of continuous variables whereas, in practice, the range of variables in the datasets can be substantially more limited. For example, level 1 & 2 skills range between 4 per cent and 64 per cent across all LSOAs rather than 0 per cent to 100 per cent. On the other hand, social renting varies between 0 per cent and 91 per cent. Awareness of variable range is therefore an important underlying factor in the interpretation of simulation results.

Some intelligence about the relationship between simulation values and range can, however, be generated. Table 5.1 replicates Table 4.2 but is designed to illustrate simulation probabilities on a comparative basis across models. The probability of transition within each model is specified at the top of columns. Where significant, each variable is evaluated in terms of the predicted transition probability impact relative to the model base.

Thus, the average conurbation core impact is indicated to be 2.4 times the base probability (~47%) in model 1 though this reduces to 1.23 times the base (~37%) in model 4. For continuous variables, the multiples are calculated for each of the lowest actual value, the mean value and the highest value in the variable distribution.

Comparison of the multiples provides an alternative way of looking at simulation results. It is clear, for example, that the 'improver' benefits of location in a high GVA area growth are more pronounced in the more polarised bands and reduce in scale as the area cohorts are expanded in size. Likewise, while the positive effects of low social renting exist in all improver models, they are more extensive in the lower band models with a similar story evident for access to proximate low skilled jobs.

As elsewhere, caution is required in interpretation of the simulation multiples. Using the maximum and minimum values within distributions is useful to indicate range, but the distribution of variable values may be skewed in one direction or another. For example, while the maximum level 1 & 2 value is some 64 per cent, the 95th percentile value is just 46 per cent. In contrast the maximum level 3 & 4 value is 95 per cent with a 95th percentile value of 93 per cent.

5.5 Simulation profiling: Multiple scenario simulation

One final set of observations is important with regard to simulations. The profiles in sections 5.4 and 5.4 are traditional simulations in that they focus primarily on simulations that involve a change in one variable at a time.

This is a perfectly adequate approach but underplays the potential of simulation structures in that it is feasible to evaluate more much complex scenarios. The latter, not surprisingly, require more extensive computation and consideration but can produce results that are much more 'tuned' to the realities on the ground.

Table 5.1: Simulation Multiples

	1	2	3	4	5	6	7	8	9	10	11	12
	Improver Models				Decliner Models (5%)				Decliner Models (10%)			
Base Transition Pr	19.7%	23.7%	27.9%	30.2%	26.9%	16.1%	10.9%	8.3%	32.1%	21.7%	15.7%	12.1%
Region												
NE												
YH						1.43	1.51	1.59		1.34	1.51	1.53
EM												
East		1.16	1.20	1.16				0.84		0.70	0.78	0.77
Lon	1.66	1.35				0.64	0.56	0.51				
SW												
WM												
NW												
LAD Types												
Lon Con	1.88	1.29	1.34	1.35					0.42	0.40	0.33	0.32
Con Core	2.40	1.72	1.38	1.23	0.55	0.47	0.40	0.38		0.70	0.69	0.64
Con Ind	1.54	1.33	1.27	1.19	0.72	0.72	0.72	0.69				0.87
NLon Dorm									1.33			
LFS City	1.47	1.37	1.37	1.26	0.60	0.63	0.73	0.72				
LFS Town								0.38				
Ind & Min							0.94	0.94		0.77	0.79	0.78
Seaside					0.62		0.77	0.78	1.70	1.85		
Rural												
Length Of Residence												
<1 Yr Res					0.82/1.02/2.34	0.77/1/2.91	0.69/1/3.71	0.66/1/4.52				0.81/1.0/2.66
1–3 Yr Res		0.78/1.0/1.67		0.87/1,01/1.47	1.22/1.07/0.53							
4–10 Yr Res			1.26/0.99/0.62	1.24/0.99/0.57								
Demographics												
WA Pop15/24c		0.82/1.0/2/3.22	0.87/1.01/2.37									
WA Pop25/64c	2.07/1.02/0.39	1.80/1.01/0.47	1.45/1.00/0.63	1.31/1.0/0.72			0.56/1.03/1.92	0.51/1.04/2.18				

continued

Table 5.1: Simulation Multiples

	1	2	3	4	5	6	7	8	9	10	11	12
	Improver Models				Decliner Models (5%)				Decliner Models (10%)			
Ethnicity												
Blk Car			0.97/0.99/1.68									0.89/1.04/2.23
Blk Afr		0.95/0.99/2.19	0.96/.0.98/1.80	0.97/0.97/1.64	1.06/1.03/0.45	1.12/1.05/0.32	1.16/1.05/0.25	1.16/1.05/0.42		1.05/1.03/0.54	1.05/1.03/0.5	1.07/1.04/0.5
Indian	0.9/0.9/3.6	0.97/0.98/1.76	0.98/0.98/1.66	0.97/0.97/1.64	-	1.03/1.03/0.65	1.03/1.03/0.77	1.03/1.03/1.07	1.06/1.06/0.18	1.07/1.07/0.17	1.06/1.06/0.26	1.06/1.06/0.36
Pakistani												
Bangladeshi					1.04/1.0/0.31	1.04/0.98/0.64	1.04/0.97/0.91	1.04/0.97/0.91	0.99/1.01/2.47			
Chinese				0.97/1.0/1.59								
Other												
Skills												
Level 1&2c	0.16/0.99/2.11							1.54/1.02/0.72				
Level 3&4	0.56/0.88/1.37	0.73/0.95/1.82	0.35/0.96/1.77	0.74/0.97/1.9				1.28/1.02/0.63		1.21/0.99/0.51	1.33/0.99/0.37	1.47/1/0.33
Tenure												
Rent: Public	3.4/1.03/0.2	3.03/0.99/0.16	2.56/0.99/0.18	2.24/0.99/0.18	0.16/0.97/2.68	0.13/0.96/4	0.11/0.97/5.51	0.09/0.94/7.25	0.24/0.97/2.36	0.25/0.97/2.98	0.21/0.98/4.02	0.19/0.96/5.05
Rent: Private	1.5/1.15/0.32	1.38/1.11/0.38	1.32/1.08/0.31	1.3/1.07/0.3	0.78/0.98/2	0.76/0.99/2.53	0.84/1/1.73	0.71/0.99/3.72	0.82/0.98/1.85	0.3/0.99/2.1	0.76/1.99/2.82	0.72/1/3.64
LAD/England												
GTGT	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	+ve, 10%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 5%	+ve, 1%	+ve, 1%	+ve, 1%
Other												
Policy												
NRF LSOA)							0.70	0.66	0.68	0.64	0.58	0.52
NDC(LSOA)				1.25			0.51	0.45		0.60	0.55	0.48
NRF (LAD)		1.25	1.15	1.15		0.84	0.81	0.79	0.75	0.62	0.56	0.51
GVA Growth												
Low Growth										1.03	1.04	1.05
High Growth	1.35	1.19	1.11	1.08		0.84	0.81	0.79				0.89
Low Skills Job Access												
Access: 5k	0.81/1/1.29	0.91/1/1.14	0.92/1/1.11	0.94/1/1.08					1.14/0.99/0.82	1.2/0.99/0.76	1.2/0.99/0.75	1.18/0.99/0.77
Access: 20k	0.46/1/1.61	-	0.71/1/1.25	0.78/1/1.11					1.74/1.01/0.71	1.51/1.06/0.71	1.63/1.01/0.67	1.7/1.01/0.65

continued

Table 5.1: Simulation Multiples

	1	2	3	4	5	6	7	8	9	10	11	12
	Improver Models				Decliner Models (5%)				Decliner Models (10%)			
Other Domains												
High SMR	0.86	0.87	0.90	0.89		1.12	1.15	1.17		1.09	1.09	1.14
Low SMR				1.36		0.22						
High Theft						0.85	0.83	0.82				
Low Theft												
High Hse Price												
Low Hse Price	0.79/0.97/1.34								1.23	1.20	1.20	1.25
High KS2												
Low Ks2									1.09	1.10	1.10	1.10
Deprived Area												
Bot 10% IMD	0.79	0.75	0.76	0.88			1.76	2.04		1.25	1.43	1.58
Bot 10%/20% IMD	0.80	0.84	0.90	0.89			1.27	1.4		1.19	1.3	1.42

This final section provides a simple example. Table 5.2 takes the model 1 profile, which has a base transition probability of 19.7 per cent. It shows the predicted probabilities of separately imposing variable values or conditions along with the predicted probability of combining all values/conditions. Model 1 suggests that an LSOA in the most deprived 10 per cent IMD band, with very high levels of social housing, very low level skills and very limited proximity to low skills jobs, has next to no chance (0.1%) of improvement – controlling for all the other factors in the model.

Table 5.2: Multiple Scenario Simulation

Variable	Value	Probability
Base	–	19.7%
Bottom 10% IMD	Yes	15.5%
Public Rental	Max	3.9%
Level 1&2/3&4 Skills	Min	1.3%
Low Skill Job Access (5km)	Min	16.1%
Combined	–	0.1%

5.6 Modelling value for money (VfM)

Another version of the models described in the text is examined within the project and used for aspects of the VfM analysis contained in the evaluation report. This version modifies the policy variables and allows for differential levels of spend across areas. The expenditure dataset is compiled by Amion Consulting and consists of per capita spend for:

- LSOA areas in NRF LADs, where spend has been targeted
- LSOA areas in NRF LADs where spend has not been targeted
- NRF LADs where spend has not been targeted on any LSOA sub-set.

Introducing a threshold (£150 per capita) means that a set of six NRF policy variables can be tested in the model, with both 'high' and 'low' spend areas defined.

The same 12 models reviewed earlier are tested. In terms of broad performance statistics, Table 5.3 provides a summary of the Hosmer & Lemeshow GOF(10) statistics, the Cragg & Uhler R^2 and the ROC statistic along with the sample size of each model (N).

As previously, all of the models pass the H&L criterion with some measure of comfort (Model 10 is the poorest performing model in this context.). The Cragg & Uhler R^2 and ROC profiles are both marginally better than the original set.

Table 5.3: Model Performance Characteristics				
Model	**N**	**H&L GOF(10)**	**Cragg & Uhler R2**	**ROC**
1	1611	0.9733	0.292	0.7992
2	3247	0.6175	0.218	0.7574
3	4872	0.6252	0.207	0.7444
4	6496	0.8462	0.194	0.7309
5	1609	0.9042	0.164	0.7166
6	3233	0.8613	0.179	0.7505
7	4843	0.8571	0.196	0.7790
8	6448	0.8857	0.221	0.8082
9	1624	0.3771	0.181	0.7231
10	3248	0.1305	0.160	0.7260
11	4872	0.6502	0.174	0.7480
12	6496	0.7246	0.192	0.7728

The performance profiles are again judged to deliver a moderately robust representation of activity across the transition bandings and Table 5.4 provides a simple summary of the statistical significance and direction of each variable across all 12 models. Each cell contains either no entry – indicating no significance – or an entry detailing the level of significance of the variable (10%, 5%, 1%) and the associated sign.

In practice, most of the variable structures remain as described in the main report text. In terms of the key indicators:

- spatial controls continue to identify location effects in London, the East and Yorkshire and The Humber along with London, conurbation, other conurbation cores, industrial conurbation and LFS cities
- ethnicity variables continue to show areas with larger black African and Indian cohorts performing better than those with higher white cohorts, and in both directions
- skills remain very important though the prominence of level 3 & 4 skills over level 1 & 2 skills is less extensive
- high GVA performance continues to play an important role in determining transition profiles
- access to low skill jobs indicators show that the role of proximity remains evident in the modified specification
- deprivation status effects are again evident in limiting improvement and enhancing prospects for decline.

Above and beyond this stability, the main difference in the models relates to the revised set of policy variables. These clearly suggest that 'intensity' of spend is an issue in determining improvement and decline rates:

- LSOA areas, in NRF LADs, where spend has been targeted:

Table 5.4: Model Significance Profiles

	1	2	3	4	5	6	7	8	9	10	11	12
	Improver Models				Decliner Models (5%)				Decliner Models (10%)			
Obs	1611	3247	4872	6496	1609	3233	4843	6448	1624	3248	4872	6496
HL	0.9733	0.6175	0.6252	0.8462	0.9042	0.8613	0.8571	0.8857	0.3771	0.1305	0.6502	0.7246
Region												
NE												
YH						+ve, 10%					+ve, 5%	+ve, 5%
EM												
East		+ve, 10%	+ve, 5%	+ve, 5%				–ve, 10%	–ve, 10%	–ve, 1%	–ve, 5%	–ve, 5%
Lon	+ve, 10%	+ve, 5%	+ve, 10%			–ve, 5%	–ve, 5%	–ve, 1%				
SW												
WM												
NW										+ve, 10%	+ve, 5%	+ve, 10%
LAD Types												
Lon Con	+ve, 1%	+ve, 5%	+ve, 1%	+ve, 1%					–ve, 5%	–ve, 1%	–ve, 1%	–ve, 1%
Con Core	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 5%	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%		–ve, 5%	–ve, 5%	–ve, 1%
Con Ind	+ve, 5%	+ve, 5%	+ve, 1%	+ve, 5%	–ve, 5%	–ve, 5%	–ve, 1%	–ve, 1%				
NLon Dorm												
LFS City		+ve, 10%	+ve, 5%	+ve, 5%	–ve, 5%	–ve, 5%	–ve, 5%	–ve, 5%				
LFS Town							–ve, 10%	–ve, 5%				
Ind & Min						–ve, 10%	–ve, 5%	–ve, 5%		–ve, 5%	–ve, 5%	–ve, 5%
Seaside					–ve, 10%	–ve, 10%	–ve, 10%	–ve, 10%	+ve, 5%	+ve, 10%		
Rural									+ve, 10%			
Length Of Residence												
<1 Yr Res					+ve, 10%	+ve, 5%	+ve, 1%	+ve, 1%			+ve, 10%	+ve, 5%
1–3 Yr Res		+ve, 5%		+ve, 5%	–ve, 10%							
4–10 Yr Res			–ve, 5%	–ve, 5%			+ve, 10%	+ve, 10%				
Demographics												
WA Pop15/24c		+ve, 10%	+ve, 10%									
WA Pop25/64c	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 5%			+ve, 5%	+ve, 1%				

continued

Table 5.4: Model Significance Profiles

	1	2	3	4	5	6	7	8	9	10	11	12
	Improver Models				Decliner Models (5%)				Decliner Models (10%)			
Ethnicity												
Blk Car			+ve, 10%									+ve, 10%
Blk Afr		+ve, 5%	+ve, 10%	+ve, 5%	–ve, 10%	–ve, 1%	–ve, 1%	–ve, 1%			–ve, 10%	–ve, 5%
Indian	+ve, 1%	+ve, 10%	+ve, 5%	+ve, 1%		–ve, 10%	–ve, 10%	–ve, 10%	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%
Pakistani												
Bangladeshi					–ve, 10%	–ve, 10%	–ve, 10%	–ve, 10%	+ve, 10%			
Chinese				+ve, 5%								
Other												
Skills												
Level 1/2c	+ve, 1%	+ve, 10%	+ve, 5%	+ve, 10%			–ve, 5%	–ve, 5%				–ve, 5%
Level ¾	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%			–ve, 5%	–ve, 5%		–ve, 5%	–ve, 1%	–ve, 1%
Tenure												
Rent: Public	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%
Rent: Private	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%
LAD/England												
GTGT	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	+ve, 10%	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 5%	+ve, 1%	+ve, 1%	+ve, 1%
Other												
Policy												
NRF LSOA Tgt: Low							–ve, 10%	–ve, 5%		–ve, 5%	–ve, 1%	–ve, 1%
NRF LSOA Tgt: High	+ve, 1%	+ve, 10%	+ve, 1%	+ve, 5%		–ve, 5%	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%
NRF LSOA NonTgt: Low								–ve, 10%	–ve, 10%	–ve, 1%	–ve, 1%	–ve, 1%
NRF LSOA NonTgt: High			+ve, 10%	+ve, 1%					–ve, 10%	–ve, 5%	–ve, 1%	–ve, 1%
NRF LAD Tgt: Low		+ve, 5%	+ve, 1%	+ve, 1%	–ve, 5%	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%
NRF LAD Tgt: High	+ve, 1%	+ve, 1%	+ve, 1%	+ve, 1%		–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%
NDC: Low										–ve, 5%	–ve, 5%	–ve, 1%
NDC: Med			+ve, 10%	+ve, 5%		–ve, 5%	–ve, 1%	–ve, 1%		–ve, 5%	–ve, 1%	–ve, 1%
NDC: High	+ve, 10%	+ve, 1%					–ve, 10%	–ve, 5%			–ve, 10%	–ve, 5%

continued

Table 5.4: Model Significance Profiles

	1	2	3	4	5	6	7	8	9	10	11	12
	Improver Models				Decliner Models (5%)				Decliner Models (10%)			
GVA Growth												
High GVA Gr	+ve, 1%	+ve, 1%	+ve, 5%	+ve, 5%		–ve, 10%	–ve, 10%	–ve, 5%	–ve, 10%			–ve, 10%
Low Skills Job Access												
Access: 5k	+ve, 5%	+ve, 5%	+ve, 5%	+ve, 5%					–ve, 1%	–ve, 1%	–ve, 1%	–ve, 1%
Access: 20k	+ve, 10%		+ve, 5%	+ve, 10%					–ve, 5%	–ve, 10%	–ve, 5%	–ve, 1%
Other Domains												
High SMR	–ve, 5%	–ve, 1%	–ve, 1%	–ve, 1%		+ve, 5%	+ve, 1%	+ve, 1%		+ve, 10%	+ve, 10%	+ve, 5%
Low SMR				+ve, 10%		–ve, 10%						
High Theft						–ve, 10%	–ve, 10%	–ve, 10%				
Low Theft												
High Hse Price												
Low Hse Price									+ve, 5%	+ve, 5%	+ve, 5%	+ve, 1%
High KS2												
Low Ks2									+ve, 10%	+ve, 5%	+ve, 10%	+ve, 10%
Deprived Area												
Bot 10% IMD		–ve, 1%	–ve, 1%	–ve, 1%		+ve, 1%	+ve, 1%	+ve, 1%		+ve, 5%	+ve, 1%	+ve, 1%
Bot 10%/20% IMD		–ve, 5%	–ve, 5%	–ve, 10%			+ve, 10%	+ve, 1%			+ve, 5%	+ve, 1%

Table 5.5: Simulation Multiples

	1	2	3	4	5	6	7	8	9	10	11	12
	Improver Models				Decliner Models (5%)				Decliner Models (10%)			
Base Transition Pr	19.7%	23.7%	27.9%	30.2%	26.9%	16.1%	10.9%	8.3%	32.1%	21.7%	15.7%	12.1%
Region												
NE												
YH						1.41					1.41	1.42
EM												
East		1.17	1.20	1.17				0.84	0.76	0.68	0.74	0.73
Lon	1.58	1/38	1.23			0.59	0.52	0.48				
SW												
WM												
NW										1.31	1.35	1.34
LAD Types												
Lon Con	2.42	1.37	1.38	1.37					0.44	0.41	0.34	0.34
Con Core	2.36	1.69	1.36	1.21	0.56	0.50	0.44	0.42		0.71	0.69	0.65
Con Ind	1.48	1.31	1.27	1.18	0.72	0.72	0.73	0.70				
NLon Dorm												
LFS City		1.28	1.32	1.23	0.62	0.63	0.73	0.72				
LFS Town							1.10	1.09				
Ind & Min						0.94	0.90	0.90		0.75	0.77	0.75
Seaside					0.63	0.73	0.73	0.73	1.67	1.84		
Rural									1.26			
Length Of Residence												
<1 Yr Res					0.81/1.01/2.36	0.76/1.01/2.91	0.69/1.0/3.54	0.66/1.00/4.20			0.85/1,01/2.03	0.82/1.00/2.41
1–3 Yr Res		0.79/1.0/1.62		0.87/1.01/1.46	1.21/0.99/0.52							
4–10 Yr Res			1.26/0.99/0.62	1.25/0.99/0.55			0.67/0.98/1.64	0.70/0.98/1.49				
Demographics												
WA Pop15/24c		0.81/1.02/3.28	0.87/1.01/2.40									
WA Pop25/64c	2.19/1.02/0.35	1.82/1.01/0.46	1.48/1.00/0.61	1.33/1.00/0.71			0.52/1.03/2.05	0.73/1.31/2.19				

continued

Table 5.5: Simulation Multiples

	1	2	3	4	5	6	7	8	9	10	11	12
	Improver Models				Decliner Models (5%)				Decliner Models (10%)			
Ethnicity												
Blk Car			0.97/0.99/1.67									0.96/1.06/2,95
Blk Afr		0.95/0.99/2.09	0.97/0.98/1.61	0.97/0.97/1.53	1.05/1.02/0.50	1.10/1.05/0.35	1.13/1.04/0.25	1.15/1.05/0.38			1.05/1.04/0.51	1.06/1.04/0.39
Indian	0.91/0.91/3.46	0.98/0.98/1.79	0.98/0.98/1.67	0.97/0.97/1.64		1.03/1.03/0.58	1.04/1.04/0,67	1.04/1.04/0.94	1.06/1.06/0.22	1.07/1.07/0.22	1.06/1.06/0.21	1.06/1.06/0.20
Pakistani												
Bangladeshi					1.03/1.00/0.37	1.03/0.98/0.74	1.04/0.97/1.02	1.03/0.97/1.35	0.99/1.01/2.46			
Chinese				0.97/0.99/1.53								
Other												
Skills												
Level 1&2c	0.13/0.99/2.23	0.63/0.99/1.19	0.69/0.99/1.13	0.77/0.99/1.08			1.64/1.03/0.66	1.86/1.03/0.60				1.59/1.03/0.74
Level 3&4	0.52/0.87/1.46	0.72/0.95/1.82	0.74/0.96/1.77	0.73/0.97/1.89			1.28/1.04/0.71	1.36/1.04/1.65		1.27/1.00/0.52	1.39/1.00/0.38	1.53/1.02/0.36
Tenure												
Rent: Public	3.49/1.02/0.18	3.04/1.00/1.82	2.56/0.99/0.17	2.35/1.00/0.18	0.16/0.98.2.67	0.13/0.97/4.02	0.11/0.96/5.54	0.10/0.94/7.27	0.25/0.97/2.36	0.25/0.98/2.98	0.21/0.98/4.04	0.18/0.96/5.03
Rent: Private	1.31/1.14/0.44	1.38/1.11/0.38	1.31/1.08/0.35	1.30/1.07/0.31	0.78/0.98/1.98	0.76/0.98/2.40	0.74/0.99/2.92	0.71/0.99/3.60	0.82/0.98/1.79	0.81/0.99/2.00	0.76/0.99/2.71	0.73/1.00/3.46
LAD/England												
GTGT	0.79	0.86	0.87	0.90	1.14	1.39	1.56	1.70	1.18	1.30	1.41	1.49
Other												
Policy												
NRF LSOA Tgt: Low							0.71	0.67		0.65	0.61	0.55
NRF LSOA Tgt: High	1.98	1.42	1.41	1.30		0.59	0.42	0.37	0.46	0.37	0.28	0.22
NRF LSOA NonTgt: Low								0.63	0.68	0.50	0.41	0.37
NRF LSOA NonTgt: High			1.75	1.97					0.31	0.30	0.14	0.09
NRF LAD Tgt: Low		1.36	1.26	1.24	0.64	0.50	0.42	0.38	0.67	0.55	0.48	0.42
NRF LAD Tgt: High	2.52	1.86	1.54	1.51		0.35	0.22	0.18	0.42	0.26	0.20	0.16
NDC: Low										0.35	0.34	0.27
NDC: Med			1.39	1.42		0.31	0.22	0.19		0.48	0.41	0.33
NDC: High	2.17	2.25					0.22	0.17			0.34	0.27

continued

Table 5.5: Simulation Multiples

	1	2	3	4	5	6	7	8	9	10	11	12
	Improver Models				Decliner Models (5%)				Decliner Models (10%)			
GVA Growth												
High Growth	1.35	1.17	1.09	1.07		0.87	0.86	0.84	0.89			0.89
Low Skills Job Access												
Access: 5k	0.81/1.01/1.31	0.90/1.00/1.15	0.92/1.00/1.12	0.95/1.00/1.08					1.14/1.00/0.82	1.20/1.00/0.75	1.21/1.00/0.75	1.19/1.00/0.76
Access: 20k	0.48/1.01/1.59		0.70/1.00/1.26	0.79/1.00/1.18					1.71/1.01/0.60	1.47/1.01/0.73	1.58/1.01/0.69	1.64/1.01/0.67
Other Domains												
High SMR	0.86	0.87	0.90	0.90		1.13	1.16	1.18		1/09	1.10	1.15
Low SMR				1.33		0.19						
High Theft						0.86	0.86	0.85				
Low Theft												
High Hse Price												
Low Hse Price									1.28	1.24	1.25	1.31
High KS2												
Low Ks2									1.09	1.09	1.09	1.09
Deprived Area												
Bot 10% IMD		0.73	0.74	0.84	1.19	1.46	1.84	2.15		1.34	1.59	1.83
Bot 10%/20% IMD		0.81	0.85	0.91			1.22	1.34			1.26	1.38

  - results suggest that improvement is enhanced by higher spend levels whereas low spend levels fail to show any significant transition improvement on non-policy areas
  - evidence that decline is limited by higher spend levels and that even low spend reduces decline compared to non-policy areas
- LSOA areas in NRFA LADs where spend has not been targeted:
  - results suggest that while improvements related to higher spend levels are present, they are more limited than where spend is targeted (above)
  - evidence that decline is limited by both higher and lower spend levels compared to non-policy areas is present, but more prevalent in the 10 per cent rather the 5 per cent sample
- NRF LADs where spend has not been targeted on any LSOA sub-set:
  - results again point to policy effects related to spend intensity.

Table 5.5 replicates Table 5.1 in the main report showing simulations of variable impacts when evaluated relative to the model base transition probability. Interpretation is subject to the same caveats noted in the text.

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ISBN 978-1-4098-2210-3

ISBN 978-1-4098-2210-3

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