New Joints: Private providers and rising demand in the English National Health Service

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Motivation

- In recent years, many governments have sought to increase the role of choice and competition in public services
  - Education (e.g. charter schools) and health care (e.g. patient choice)
- These policies aim to improve quality and efficiency through increased competition
  - Assumes that the size of the market is fixed and providers must compete for market share
- However, the decision to use these services may be affected by the characteristics of potential suppliers, so market size may change
  - This may have consequences for competitive pressures

This paper

- We examine a UK reform in the 2000s that introduced private providers to the market for publicly-funded elective surgery
  - "Independent Sector Providers" (ISPs) were allowed to treat National Health Service (NHS) funded elective patients in England.
- These reforms increased the number of hospitals available by two-thirds (160 in 2002 to 260 in 2010).
- The objectives were initially to relieve capacity constraints; later expanded to increasing choice and providing competition for NHS hospitals (Naylor & Gregory, 2009).
- We consider the effects of the reform on the quality and efficiency of incumbent public hospitals, and the overall effect on the public finances

Research Questions

- Research Questions:
  1. What is the effect of the ISP reforms on patient volumes and outcomes in NHS hospitals?
  2. Did the reforms increase the number of patients who chose to have a hip replacement (rather than simply treating existing patients on the waiting list)?
  3. To what extent did patients substitute for privately-funded procedures?

- Why hip replacements?
  - Common procedure performed by all major NHS hospitals.
  - ISPs had a market share of almost 20% by 2010/11.
  - Rarely available data on private-pay sector

- Use variation in the introduction ISPs over time and space, and patient preferences for short travel distances for identification.

Contribution

1. Public sector reforms and competition
   - Adds to an existing literature on health care competition in England (Cooper et al., 2011; Gaynor et al., 2012. 2016) and education in the US (Imberman, 2011; Hanushek et al., 2007)
   - Increasing volumes reduce competitive pressures in public markets
2. Hospital entry/consolidation
   - Adds to the existing evidence on impacts on prices, productivity and quality (Town et al., 2006; Ho, 2006; Dafny, 2009; Gaynor et al, 2012)
3. Patient choice and the modelling of patient demand.
   - Augments existing work taking set of patients as given (Beckert et al., 2012; Ho, 2006; Kessler & McClellan, 2000)
   - Alternative interpretation of "supplier induced demand".

Preview of our findings

- The introduction of ISPs reduced the waiting times of NHS hospitals but had no effect on volumes or quality measures.
- We find evidence that ISPs increased demand for elective hip replacements in areas where an ISP was introduced closer than the nearest NHS hospital.
  - Impact remains when we instrument for ISP location
  - Additional annual costs of £4 million (5.2 million USD) for hip replacements
- We find no evidence of patients switching from the private pay sector to the public pay sector

Institutional Background

- Majority of health care in England is funded through general taxation, and provided through the National Health Service (NHS).
- Patients access elective hospital care through a referral from their GP.
- Inpatient and outpatient hospital care historically provided by state owned and run NHS Acute Trusts or hospitals.
- Treatment rationed through waiting times.
- Hospitals receive per patient payments based on the treatments they provide, prices fixed at national level (Payment by Results)
- Payments made by organisations in charge of funding treatment for patients in their region. At this time, 152 Primary Care Trust (areas) - e.g, Oxfordshire.

ISP Reforms

- Formalised and expanded access private or "Independent Sector Providers" had to NHS markets for elective care.

- Wave 1 (commencing 2003):
  - Aim to use ISPs to address capacity constraints within the NHS.
  - ISPs were to concentrate on routine patients.
  - ISPs were privately owned but only treated NHS patients

- Wave 2 (commencing 2006):
  - Objectives: providing choice for patients, increasing competition for NHS hospitals and fostering innovation.
  - New ISPs were private hospitals that treated NHS and privately funded patients alongside one another.

- By 2010/11, 67% of private hospitals also operated as ISPs.

Hip replacement volumes

Figure: Numbers of NHS-funded hip replacements by provider type, 2002/03 to 2010/11
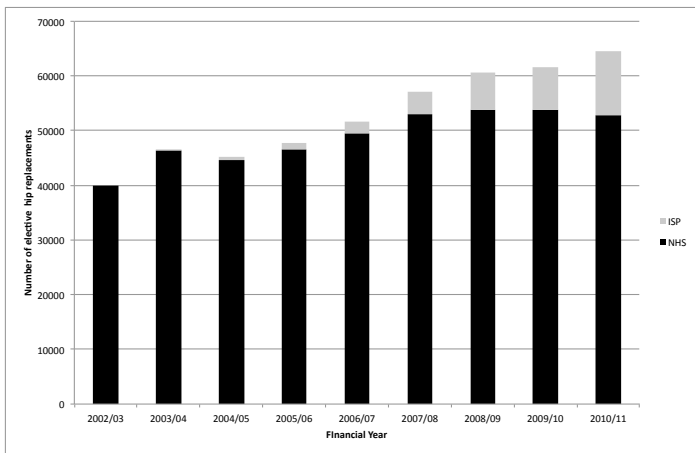
Notes: Hospital Episodes Statistics, April 2002- March 2011.

Figure: The spread of ISPs across England (2006/7,2008/9 and 2010/11)
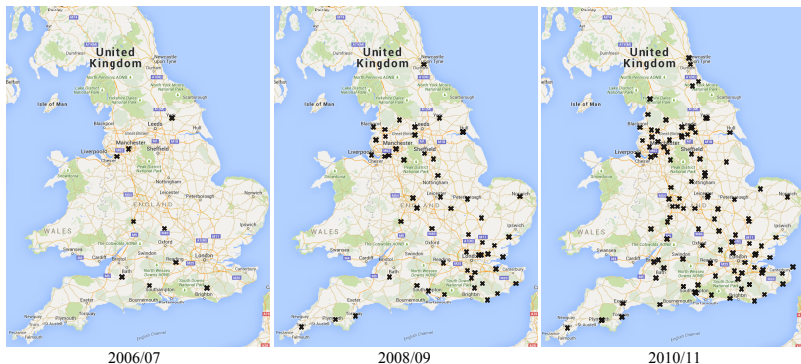
Notes: Restricted to ISPs performing at least 20 procedures in a given year.

- ISP sites grew from 9 in 2006/07 to 54 in 2008/09 and 106 in 2010/11.
- NHS hospitals stable (~160 throughout). Hospitals available to patients therefore increased by two-thirds.

The demand for hip replacements I

- All elective hip replacement patients in the NHS must go through two steps before they can have a procedure
  - GP referral to an orthopedic specialist.
  - A specialist decides that the patient should have a hip replacement, and the patient agrees to have the procedure.
- Patient i chooses (with GP) which of J_i hospitals to be referred to
- Patient i may then undergo a procedure after referral

The demand for hip replacements II

- Indirect utility of patient i in hospital j, u_{ij}, is given by:

$$u_{ij} = f_i(D_{ij}, W_j, Q_j, \varepsilon_{ij})$$

- Patient utility is decreasing in distance $(f\prime(D_{ij}) < 0)$ and waiting times $(f\prime(W_j) < 0)$
- Patient utility is increasing in quality $(f\prime(Q_j) > 0)$
- Patients and GPs jointly choose between an outpatient referral to hospital j, which maximises expected utility $E(u_{ij}) = max(E(u_{i1})...E(u_{iJ}))$

Potential impacts of the reform I

- The impact of the reform on the number of procedures depends on two assumptions:
  - Whether the number of patients seeking a referral is fixed
  - Whether the clinical threshold in the second stage remains constant
- The existing literature which estimates discrete choice models to assess the determinants of hospital choice [Gaynor et al., 2016; Beckert et al., 2012; Kessler and McClellan, 2000] typically assumes that the number of patients is fixed
- Under this scenario, ISP entrance will increase competition among providers, decreasing waiting times and potentially increasing quality and efficiency.

Potential impacts of the reform II

- However, it is unlikely that either of these assumptions holds:
  - The volume of patients increased by 60% since the introduction of ISPs
  - ISPs may be expected to have a lower threshold because there is a lower opportunity cost due to spare capacity
- The introduction of ISPs may increase annual volumes through three mechanisms:
  - **Reduced waiting times**: increased volumes due to more patients treated in a given year
  - **Reduced clinical thresholds**: increased ISP volume for a given number of referrals
  - **Outside option**: Expansion of the hospital set for some patients may lead to patients switching from an outside option (no procedure or privately-financed procedure) to a publicly-funded procedure at an ISP
- The extent to which these mechanisms operate will determine the impact of the reform on NHS hospital performance and the public finances

Data

- To analyse the impact of the reform we use the Hospital Episode Statistics
- Contain the records of all NHS-funded hospital care in England
  - Diagnoses and procedures; hospital identifiers, dates of admission/discharge etc, age, sex
- Location information is at the Middle Layer Super Output Area (MSOA)
  - 6,781 MSOAs in England, with an average population of 7,500 in 2010/11.
  - Augmented with MSOA level characteristics.
  - Geocoded to identify the nearest ISP and NHS hospital to the centroid of the MSOA in each year.
- Use data on hip replacements from 2002/03 to 2010/11.

Baseline specification

- We analyse the impact of the reform on waiting times, volumes, and quality and efficiency measures in NHS hospitals
- To examine the impact on hospital j, we estimate equations of the following form:

$$Outcome_{jt} = \beta_0 + \beta_1 Exposure_{jt} + \beta_2 Z_{jt} + \lambda_t + \gamma_j + \varepsilon_{jt}$$

- β_1 is the coefficient of interest, and estimates the impact of exposure to ISP competition on NHS hospital outcomes
    - $Exposure_{jt}$ is measured as the proportion of the MSOAs served by the hospital with an ISP located closer than an NHS hospital
- Z_{jt} represent time varying characteristics of hospital j and the local population.
- λ_t and γ_j control for year and NHS hospitals fixed effects respectively

Table: NHS hospital outcomes and the introduction of ISPs, OLS results, 2002/03 to 2010/11

	Patients	Waiting time (days)	Pre-op length of stay (days)	30-day FNOF readmission	30-day FNOF in-hospital mortality
	(1)	(2)	(3)	(4)	(5)
	OLS	OLS	OLS	OLS	OLS
% MSOAs ISP closest provider	-25.80	-33.14***	-0.066	-0.002	-0.0004
	(18.25)	(7.96)	(0.083)	(0.038)	(0.005)
Observations	1,197	1,197	1,197	1,197	1,197
R-squared	0.235	0.811	0.469	0.076	0.096
Number of hospitals	133	133	133	133	133

Notes: *** denotes significance at 1%, ** at 5%, and * at 1% level. Observations are at the hospital level. The sample includes hospitals that data on waiting times and patient numbers in both 2002/03 and 2010/11. The variable of interest in all odd columns is the change in % MSOAs where the ISPs is the closest provider between 2002/03 and 2010/11. This is calculated by assigning MSOAs their closest NHS hospitals, using straightline distance measures and calculating the share of these MSOAs that have a closer ISP in each year. In even columns the variable of interest is the % MSOAs where an ISP is located within 5km. All columns are estimated using OLS.

- ISP exposure reduced waiting times (moving from zero to mean exposure reduces waiting times by 7.6 days per year, relative to a reduction of 151 days between 2002 and 2010),
- No other effects

Threats to identification

- Previous results rely on assumption that, conditional on the health characteristics of the local population, Z_{jt}, the entry of ISPs is uncorrelated with other determinants of hospital outcomes.
- This assumption would be violated if ISPs were introduced for reasons other than local patient health (e.g. waiting times of the hospital)
- Address this concern by instrumenting the presence of ISPs with pre-existing private hospital sites
  - By 2010/11, >90% of ISPs are existing private providers (operate in both private and NHS market)
  - These providers are located in these areas for historical reasons

Instrumental Variables

- For the instrument to be valid it must fulfil two criteria:
    - Private provider location must influence ISP location (relevance restriction)
    - The existence of a private provider only affects NHS outcomes through its effects on ISP location (exclusion restriction)
- The exclusion restriction may not hold *in a given year* - the presence of private providers is likely to affect NHS outcomes for hip replacements (volumes, quality etc)
- However, the existence of these sites should not affect the change in NHS volumes between 2002/03 and 2010/11 (other than through their influence on ISP location)
    - Motivates IV difference-in-difference estimation

Table: Change in hip replacement patient numbers and mean waiting times in NHS hospitals and the introduction of ISPs, IV results, 2002/03 to 2010/11

	Δ Patients		Δ waiting time (days)		Δ pre-op length of stay (days)		Δ 30-day FNOF readmission		Δ 30-day FNOF in-hospital mortality	
	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV	(7) OLS	(8) IV	(9) OLS	(10) IV
Δ % MSOAs ISP closest provider	12.44 (42.47)	28.42 (103.1)	-68.42** (22.32)	-141.90** (59.47)	-0.020 (0.187)	0.071 (0.417)	0.044 (0.166)	0.0145 (0.085)	-0.010 (0.010)	-0.030 (0.023)
First stage F-stat	-	33.52	-	33.52	-	33.52	-	33.52	-	33.52
Observations	133	133	133	133	133	133	133	133	133	133
R-squared	0.000	0.001	0.058	0.056	0.000	0.004	0.002	0.001	0.006	0.005

Notes: *** denotes significance at 1%, ** at 5%, and * at 1% level. Observations are at the hospital level The sample includes hospitals that data on waiting times and patient numbers in both 2002/03 and 2010/11. The variable of interest in all odd columns is the change in % MSOAs where the ISPs is the closest provider between 2002/03 and 2010/11. All columns are estimated using IV where the change in % MSOAs where the ISPs is the closest provider is instrumented with the % of MSOA where was a private hospital site closer than the nearest NHS trust in 2002.

- IV estimates: moving from zero to mean exposure reduces waiting times by 33 days (22% of mean reduction)

- The previous results indicate that the ISP reform achieved the original objective of reducing waiting times at NHS hospitals
  - However, the reform appears to be less successful at improving efficiency and quality
- One potential reason for this is that volumes at NHS hospitals were largely unchanged
  - Overall volumes simply increased
- We therefore want to understand how and why the introduction of ISPs increased the volume of hip replacements
- Exploit variation in distance to nearest provider, driven by ISP reform
  - Do analysis within PCT: expansion of supply common in the areas, but distance to provider varies

Empirical Specification

- Number of (age/sex standardized to English population in 2002) NHS-funded hip replacements for residents of MSOA m in PCT p and year t:

$$Hips_{mpt} \; = \; \alpha + \beta ISP_{mpt} + \gamma_m + \mu_{pt} + X_{mpt} + \varepsilon_{mpt}$$

- β, the effect of introducing an ISP as the closest provider to MSOA m on number of residents admitted for NHS-funded hip replacements
- PCT area specific time trends, μ_{pt}, control for PCT-wide factors that vary over time.
- X_{mpt} - time varying MSOA measures: (standardized) number of admissions for fractured neck of femur and acute coronary syndrome; nearest hospital emergency readmissions within 28 days of discharge; number of house sales and median house price.

Table: Fixed effects estimates of the effect of ISPs on standardized elective hip replacements per MSOA

	(1) MSOA FE	(2) PCT TT	(3) +controls	(4) Rel Distance
ISP location				
ISP closest hospital	0.868***	0.462***	0.457***	
	(0.158)	(0.114)	(0.113)	
ISP dist rel to nearest NHS hosp				
Rel to 10km further				
5-10km further				-0.0215
				(0.0953)
0-5km further				0.304**
				(0.136)
ISP closer				0.626***
				(0.168)
MSOA Fixed Effects	Yes	Yes	Yes	Yes
Time-varying MSOA Characteristics	No	No	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
PCT area x Year Fixed Effects	No	Yes	Yes	Yes
Observations	61,029	61,029	61,029	61,029
R-squared	0.094	0.194	0.194	0.194
Number of MSOA	6,781	6,781	6,781	6,781

Notes: *** denotes significance at 1%, ** at 5%, and * at 1% level. Observations are at the MSOA year level. Providers that conduct fewer than five annual procedures are excluded. The dependent variable in all columns is the number of admissions for an NHS-funded elective hip replacement amoungst MSOA residents, age/sex standardized to the English population in 2002.

Summarising the results

- Introducing an ISP closer than the nearest NHS hospital increases the number of hip replacements per MSOA per year by 0.5 hips, compared to a 2002 pre-reform average of 5.8.

  - In 2010/11, there were 1,471 treated MSOAs - implying an increase of 780 hip replacements across England.
  - The tariff or price paid to ISPs ≈ £5000 per procedure ⇒ additional costs of £3.9million.

- Using final column estimates and applying to 2010/11:

  - 1,750 additional hip replacements, costing a total of £8.75 million

- Robust to using different measures of distance and alternative definitions of the relevant ISPs (wave 1/2, lower threshold).

Table: IV estimates: ISP introduction and the change in elective hip replacements per MSOA, 2002/03 to 2010/11

	(1) OLS	(2) IV
ISP location		
Change ISP closest provider	0.700***	0.643***
	(0.169)	(0.228)
Change in MSOA characeristics	Yes	Yes
Change in Nrest hosp characteristics	Yes	Yes
PCT FE	Yes	Yes
Observations	6,781	6,781
R-squared	0.011	0.011
F-stat (First stage)		130.3

Notes: *** denotes significance at 1%, ** at 5%, and * at 1% level. Observations are at the MSOA year level. The dependent variable is the change in the standardized number of elective hip replacements between 2002/03 and 2010/11 (standardized hip replacements in 2010/11 - standardized hip replacements in 2002/03). Standard errors are robust to the presence of heteroskedasticity and clustered at the PCT level.

Mechanisms

1. Waiting times:
   - Assign patients to referral year (not treatment year) to shut down WT mechanism
   - Results are slightly smaller in magnitude, but remain statistically significant

2. Threshold:
   - Sort patients by comorbidities and run analysis separately
   - Increases in all health categories, but greatest for 'healthy' patients
   - This suggests that the clinical threshold decreased

Private pay substitution

- We use private-pay data to examine whether privately-funded procedures decreases in areas where ISPs were introduced
- Use the National Joint Registry, which contains a clinical audit of all joint replacements in England
- We find that while NHS-funded and total procedures increased in areas where the ISP became the nearest provider, there were no significant changes in private hip replacements
- This suggests that the additional procedures were genuinely 'new' rather than substitution

Summary

- The ISP reforms increased the number of hospitals hip replacement patients were able to choose between by two thirds.

- We find evidence that the reforms reduced waiting times for NHS patients, but had no effect on NHS volumes, quality or efficiency

- The introduction of an ISP as the closest provider of hip replacements increased numbers of hip replacements per MSOA by 0.5

  - approx 9% of 2002/03 average
  - 20% of the average rise of 2.6 hip replacements
  - 7% of the hip replacements conducted by ISPs in 2010/11.

- No evidence of substitution between publicly and privately funded hip replacements

Thank you

Waiting times

Figure: Inpatient Waiting Times for Elective Hip Replacement, 2000/01 - 2010/11
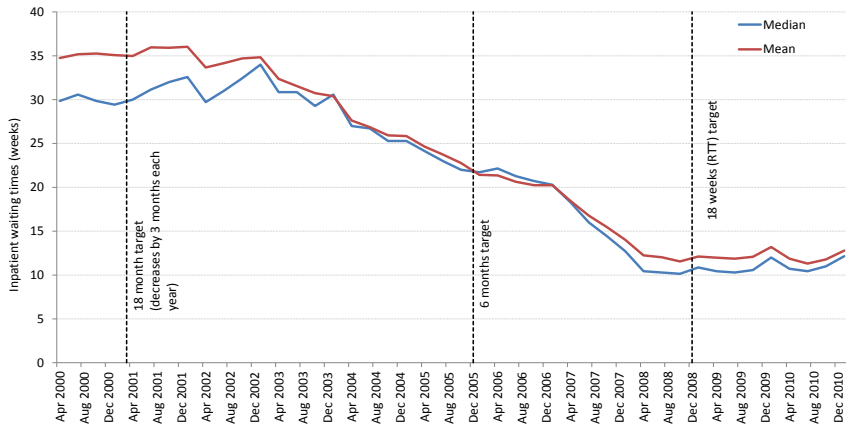
Table: ISP treatment and volumes of hip replacements 2002/03 to 2010/11

	% ISP Nearest Provider	% of MSOA hips conducted by ISPs		% ISP hips for pats with ISP closest
		NHS closest	ISP closest	
2002/03	0	0	0	0
2003/04	0	0	0	0
2004/05	2.9	1.2	4.9	10.7
2005/06	3.2	2.0	9.3	15.1
2006/07	1.9	2.9	23.6	15.1
2007/08	4.1	5.9	26.5	18.3
2008/09	12.5	7.9	22.4	30.9
2009/10	10.8	8.9	25.5	27.2
2010/11	21.7	12.5	27.0	38.7

Notes: Author's calculations using HES inpatient data April 2003 to March 2011, collapsed to the MSOA level. There was no ISP activity recorded in HES in 2002/03. Figures for 2003/04 have been omitted due to the small sample size.

- The share of MSOAs that were treated increases over time.

Table: ISP treatment and volumes of hip replacements, 2002/03 to 2010/11

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2003/04	0	0	0	0
2004/05	2.9	1.2	4.9	10.7
2005/06	3.2	2.0	9.3	15.1
2006/07	1.9	2.9	23.6	15.1
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Notes: Author's calculations using HES inpatient data April 2003 to March 2011, collapsed to the MSOA level. There was no ISP activity recorded in HES in 2002/03. Figures for 2003/04 have been omitted due to the small sample size.

- The probability of having a hip replacement at an ISP is 2-3 times higher if an ISP is the closest hospital

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		NHS closest	ISP closest	
2002/03	0	0	0	0
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2005/06	3.2	2.0	9.3	15.1
2006/07	1.9	2.9	23.6	15.1
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- But... Most patients that have hip replacements conducted at ISPs do not have an ISP as the closest hospital.

Table: Robustness: Alternative definitions of supply constraints

	(1) Baseline	(2) NH TT	(3) NH&PCT TT	(4) 2002 PCT boundaries	(5) Post 2006
Sample			2002/03 - 2010/11		2006/07 - 2010/11
ISP location					
ISP closest provider	0.529***	0.477***	0.459***	0.320***	0.402***
	(0.102)	(0.106)	(0.106)	(0.0934)	(0.107)
MSOA Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time-varying MSOA Characteristics	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
PCT area x Year Fixed Effects	Yes	No	Yes	Yes	Yes
Nrest NHS hosp X Year Fixed Effects	No	Yes	Yes	No	No
Observations	61,029	61,029	61,029	61,029	33,905
R-squared	0.194	0.192	0.229	0.232	0.129
Number of MSOA	6,781	6,781	6,781	6,781	6,781

Notes: *** denotes significance at 1%, ** at 5%, and * at 1% level. Observations are at the MSOA year level.

Table: The odds of having an ISP nearer than the nearest NHS hospital in 2010/11

	(1)	(2)	(3)
Nrst NHS Hosp Wait 2003 (SD)	1.352**	1.195**	1.141
	(0.102)	(0.0900)	(0.117)
MSOA Wait Time 2003 (SD)	0.983	0.963	0.943
	(0.0356)	(0.0355)	(0.0451)
Average hip replacements in 2003 and 2004	0.972*	0.927***	0.939**
	(0.0159)	(0.0176)	(0.0242)
Private hospital close			29.25***
			(7.843)
NHS hospital site (>30 beds) close			2.028***
			(0.384)
Nearest NHS Hosp Characteristics			
Teaching Hosp		1.597*	0.970
		(0.419)	(0.398)
Dist (km)		1.120***	1.078***
		(0.0270)	(0.0294)
Distance sq (km)		0.997***	0.998**
		(0.000760)	(0.000768)
2003 MSOA Characteristics	No	Yes	Yes
Observations	6,710	6,710	6,710
Pseudo R-squared	0.0127	0.0731	0.404

Notes: *** denotes significance at 1%, ** at 5%, and * at 1% level. The dependent variable is an indicator equal to one if the straight line distance to the nearest ISP in 2010/11 is less than the straight line distance to the nearest hospital. Coefficients provide odds ratios from logistic specification.