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« Geographic variation in hospitalization in France. »

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Geographic variation utilization of hospital services in France: economic motives and policy implications

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Overall background

- Market forces should efficiently allocate scarce resources
- Kenneth Arrow suggested that the health services delivery market is different, and factors such as inadequate regulation and oversight might impede efficient resource allocation
  - Might excessive geographic variation in health services utilization reflect such deficiencies?

Geographic variation

- Jack Wennberg's work in the US has identified three categories of healthcare services:
  - Effective care (β blockers)
  - Preference sensitive care (knee replacement)
  - Supply sensitive care (beds & hospitalizations)

Two foci

- Geographic variation in hospital admission for elective surgical procedures for preference sensitive care conditions
  - Scheduled procedures with medical alternatives
- Geographic variation in hospitalization for Ambulatory Care Sensitive Conditions (ACSCs)
  - Considered wasteful and avoidable
  - A supply sensitive condition, often inversely related to local primary care supply

Why these are important research areas

- High degrees of unexplained geographic variation in practice patterns suggest physician uncertainty and may represent wasteful use of resources that could be otherwise deployed.
  - Interventions might include care pathways or guidelines
- Recent French policies that promotes market competition between for-profit and not-for-profit hospitals might inadvertently encourage over-utilization and inadvertently accelerate costs.
- Understanding costs associated with avoidable admissions might stimulate policy discussion.

Data sources

- Publicly available data (from Observatoires Régionaux de Santé) on :
  - All admissions to French medical and surgical hospitals in 2008-2010 that included patient and hospitalization characteristics
  - Hospital characteristics
  - Census (for age-sex specific denominators)
  - Resource supply (MDs and beds)
  - Reimbursements (at GHM (similar to DRG) level)

Methods

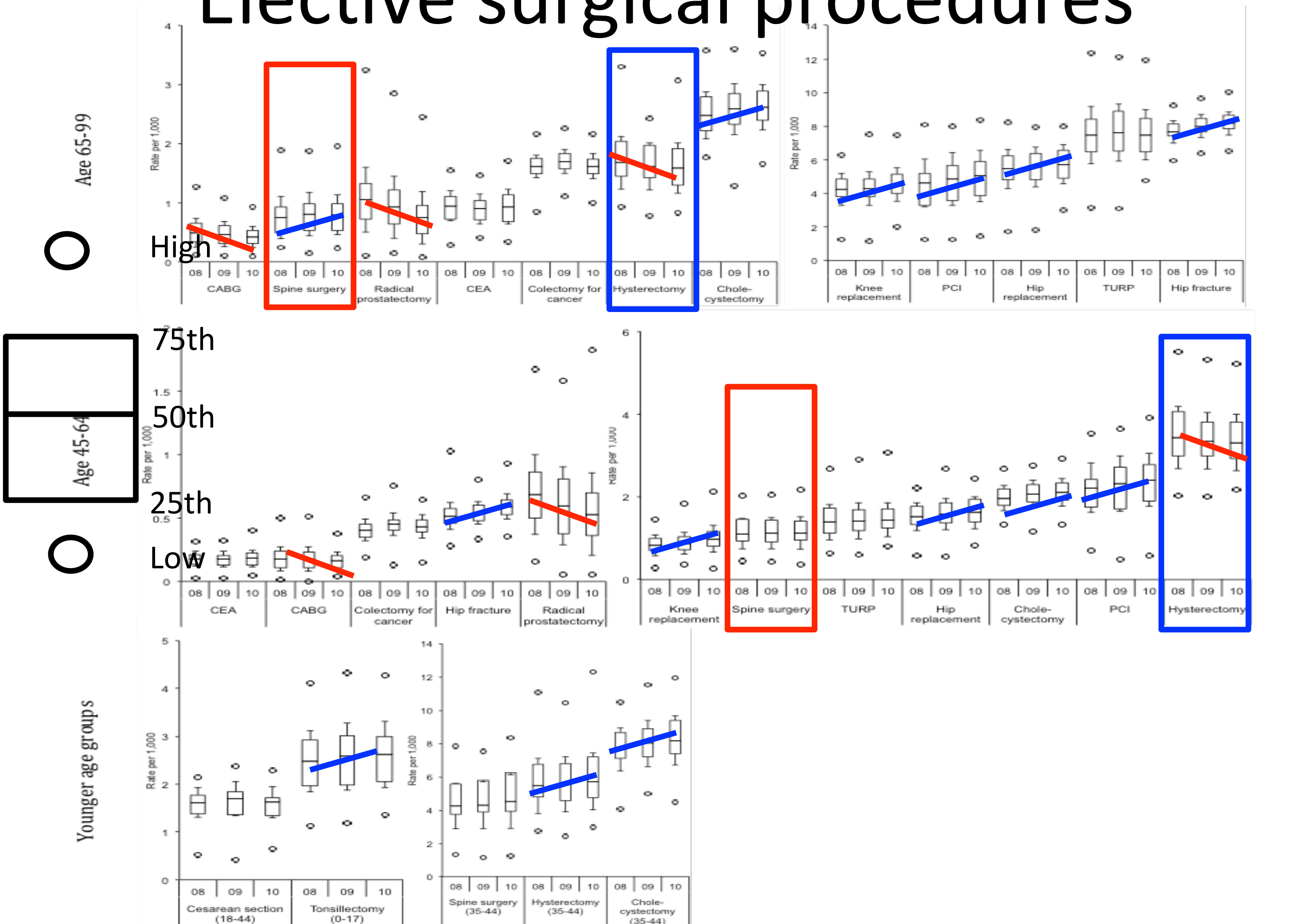
- Dartmouth Atlas methods to calculate age-sex adjusted department level rates for 94 departments in mainland France
- These rates to calculate four commonly used measures of geographic variation
  - Extreme ratio, interquartile ratio, and systematic component of variation
- Used data from the literature to compare French results to those from other countries.
- Linear and spatial regression techniques to explore associations between rates and department level variables (like population density, median income, and medical resource supply)
- Considered differences in how for-profit and not-for-profit hospital sectors in France provided care
- Calculated reimbursements associated with care provided

Two specific methods

- Systematic component of variation (SCV)
  - Addresses issues with other variation measures
    - Variance and standard deviation: influenced by absolute rates
    - Coefficient of variation: influenced by underlying population size
  - Adapted from proportional hazards model, SCV estimates geographic variation around a national norm
    - SCV > 5 means high variation; >10 means very high variation
- Spatial regression techniques
  - Addresses spatial autocorrelation
  - Specify and weight values according to a proximity matrix
  - Process:
    - Run OLS
    - Test for spatial autocorrelation
    - If there is, use spatial regression with a spatial lag term

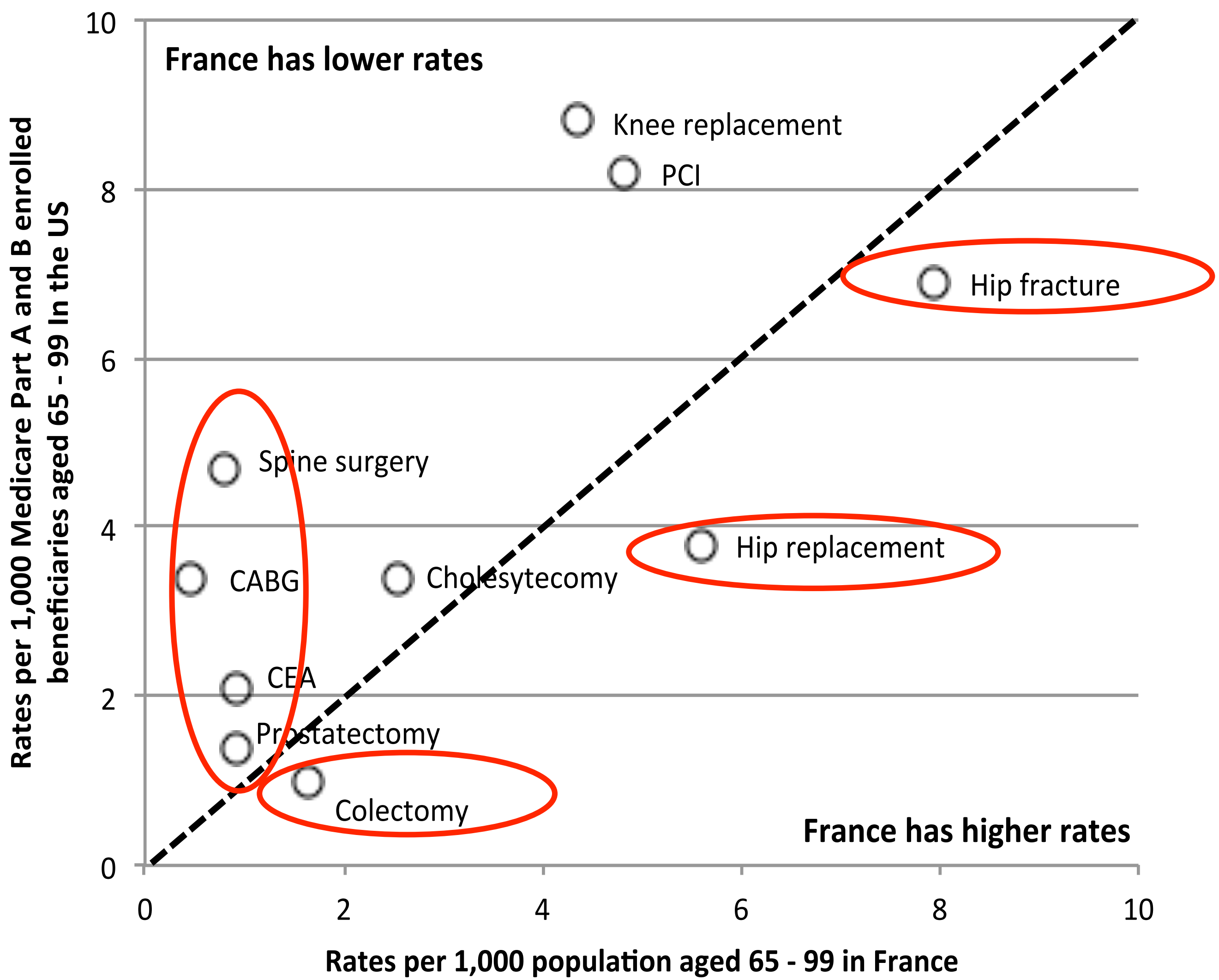
Geographic variation in hospitalization for elective surgical care for preference sensitive conditions

Elective surgical procedures



Mostly, France had lower per-capita rates of these surgeries than did the US

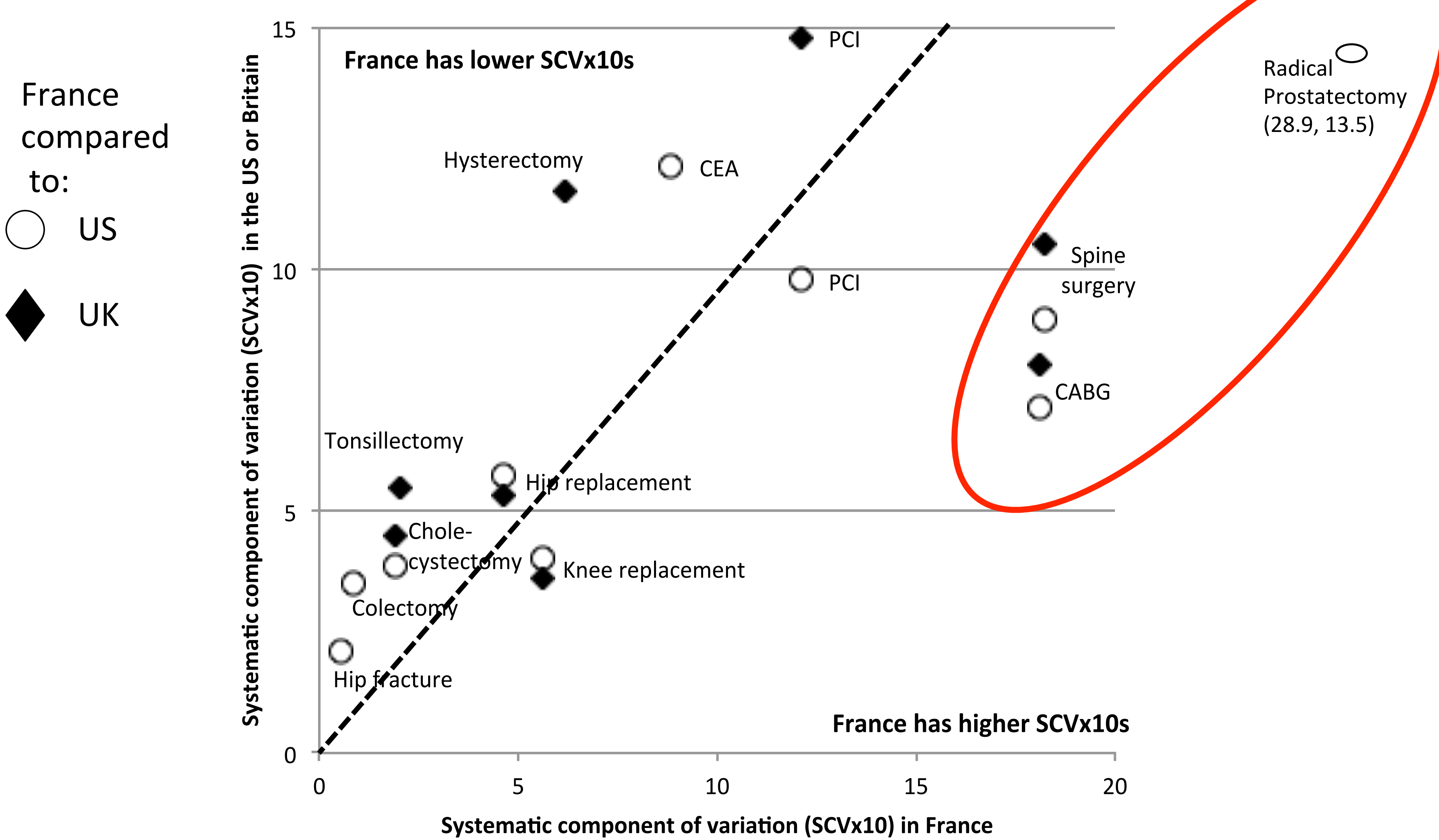
(shown: age- and sex-adjusted rates in 2010 for 65+)



Elective surgical procedures showed substantial geographic variation
(shown, results for 2008-2010, age 65+)

	Extreme ratio	Interquartile ratio	Coefficient of variation	SCV
Hip Fracture	1.5	1.1	0.1	0.6
Colectomy	2.3	1.2	0.1	1.1
Cholecystectomy	2.3	1.2	0.2	2.2
TURP	3.5	1.3	0.2	4.6
Hip Replacement	3.9	1.3	0.2	5.1
Hysterectomy	3.5	1.4	0.3	5.4
Knee replacement	5.1	1.3	0.2	6.2
Tonsillectomy	3.5	1.5	0.3	7.8
CEA	4.6	1.6	0.3	10.0
PCI	6.2	1.6	0.3	13.6
Spine Surgery	9.5	1.9	0.5	20.2
CABG	10.2	1.9	0.4	22.5
Radical prostatectomy	27.6	1.9	0.5	31.3

SCVs were similar in France, the US, and the UK (with exceptions)



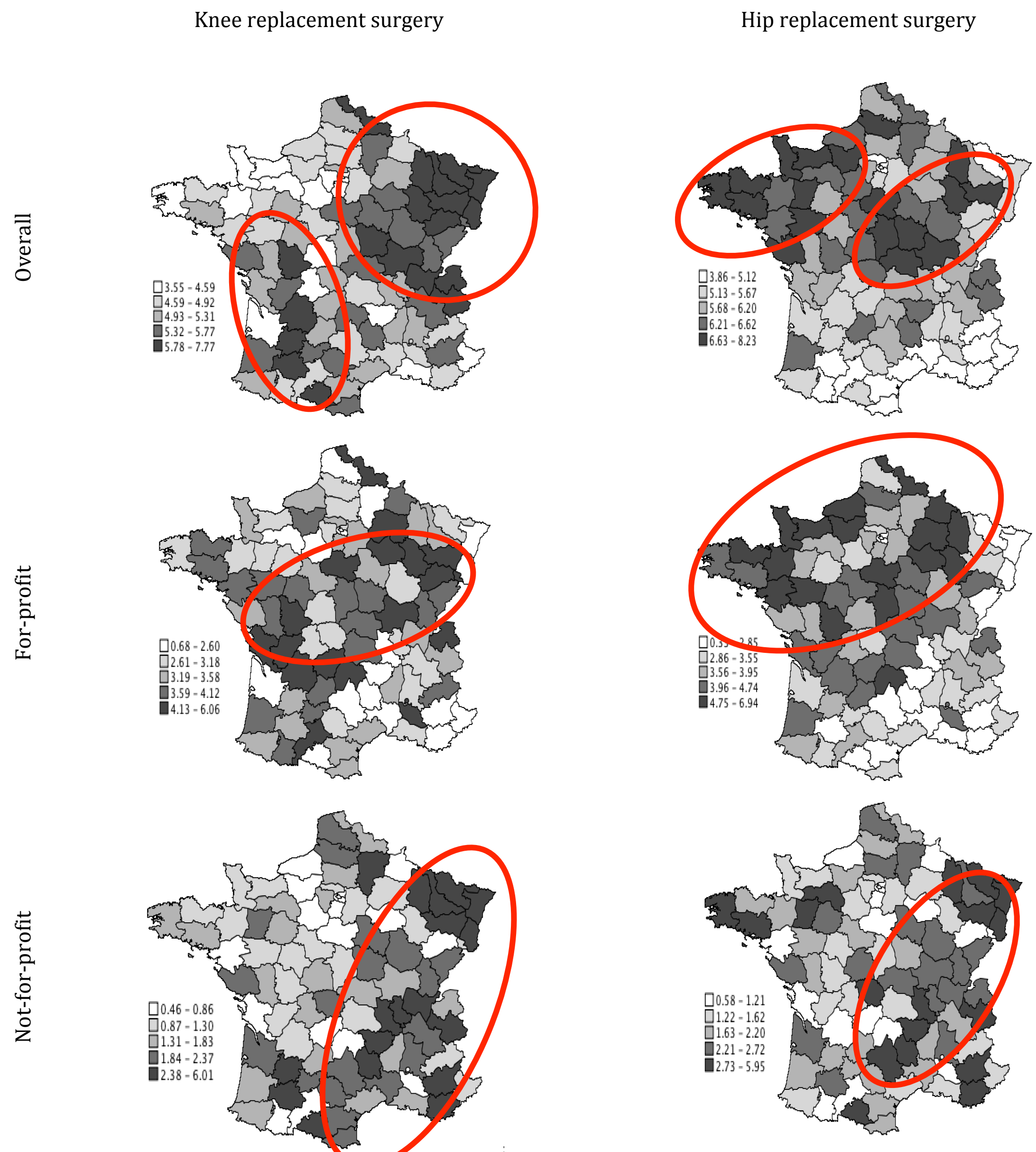
The relative roles of FP and NFP hospitals in providing elective surgical care for preference sensitive conditions

Hip and knee replacement surgery

Quintiles

- Frequently used in Dartmouth Atlas work to aggregate rates to some interpretable level.
- In the maps I show, the highest quintile rates are the darkest, the lowest quintile rates are the lightest

Evidence of procedure-specific geographic variation



Use of for-profit and not-for-profit sectors for hip fracture and hip and knee replacement

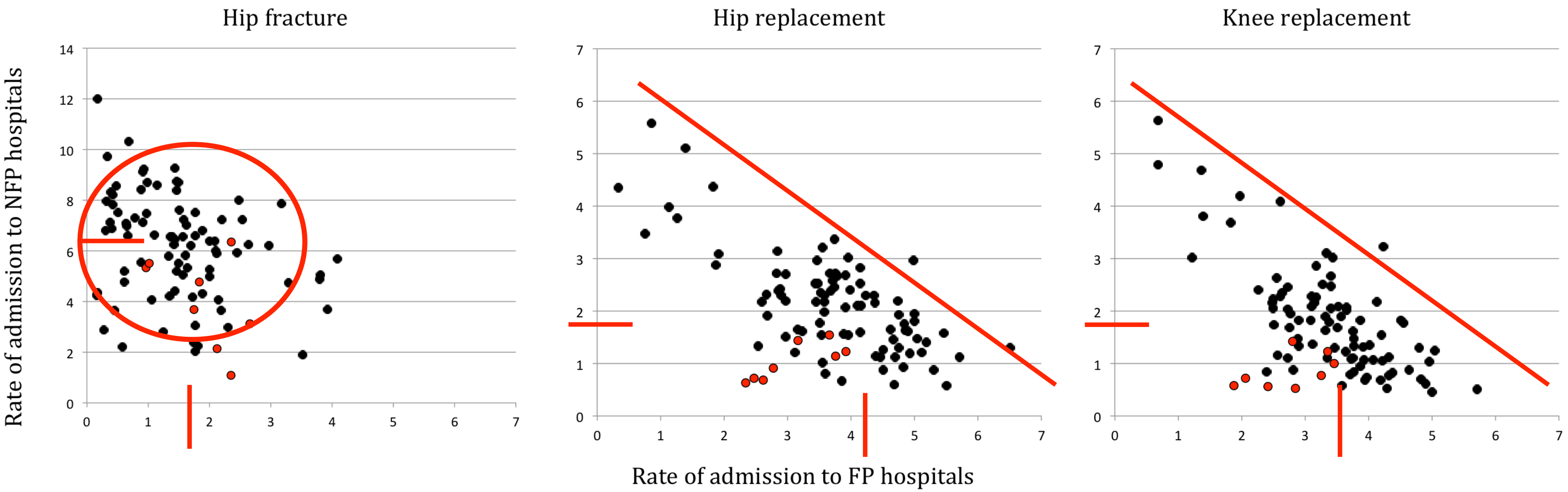


Table 2. Results of spatial regression analysis **at the department level** that used the Queen-contiguity method showing coefficients predicting hospital-type-specific rates of knee replacement surgery, hip replacement surgery and hip fracture for two age groups. Bold text indicates p<0.001 and italic text indicates p>0.05 but <0.10. Empty cells indicate p>0.10 and parenthesis show p-values when p>0.001 and <0.1. Overall age-specific surgical bed supply per capita is not statistically significantly associated with overall age-specific rates of admission.

		Age 45-64						Age 65-99					
		2009			2010			2009			2010		
		Knee replace	Hip replace	Hip fracture	Knee replace	Hip replace	Hip fracture	Knee replace	Hip replace	Hip fracture	Knee replace	Hip replace	Hip fracture
Predicting for-profit procedure rates	Age specific orthopedic surgeon supply per capita	*-0.126 (0.058)*	*-0.132 (0.095)*				!		*-0.211 (0.047)*				
	Population density x 100,000		*3.314 (0.040)*		*2.563 $ (0.079)*	*2.826 $ (0.087)*	*0.043 $ (0.019)*		*15.084 (0.005)*			*9.525 (0.066)*	
	Median income x 10,000	*-0.412 (0.011)*			*-0.545 (0.002)*	*-0.323 $ (0.100)*							*1.233 (0.054)*
	Inter-decile income ratio									*0.214 (0.078)*			*0.267 (0.050)*
	Among those 65 and older, enrolled in ASPA	*				*-0.050 (0.021)*			*-0.178 (0.011)*		*-0.120 $ (0.073)*	*-0.216 (0.001)*	
	Non-workforce participants in the working age population (%)												
	For-profit surgical bed supply per capita x 1,000	**8.508**	**14.478**	**1.870**	**9.146**	**13.875**	**2.574**	**18.362**	**22.462**	**16.581**	**18.411**	**22.004**	**18.939**
	Not-for-profit bed supply per capita x 1,000	**-6.304**	**-8.691**	*-0.994 (0.005)*	**-6.886**	**-7.440**	*-1.179 (0.004)*	**-13.343**	**-14.176**	**-7.257**	**-11.992**	**-12.082**	**-8.047**
	Spatial lag term	*0.293 (0.017)*	*0.336 (0.003)*	*0.246 (0.060)*	**0.400**	**0.471**		*0.219 (0.072)*	*0.391 (0.005)*	*0.236 (0.055)*	*0.291 (0.013)*	**0.465**	
	LR statistic of spatial dependence test	*4.793 (0.029)*	*7.206 (0.007)*	*3.088 (0.079)*	*9.183 (0.002)*	**14.892**		*3.069 (0.080)*	*7.758 (0.005)*	*3.204 (0.073)*	*5.195 (0.023)*	**18.594**	
	Model adjusted r-square	0.385	0.540	0.279	0.412	0.408	0.301	0.463	0.595	0.443	0.463	0.635	0.448
Predicting not-for-profit specific procedure rates	Age specific orthopedic surgeon supply per capita						*	*0.174 (0.062)*			*0.235 (0.024)*	*0.184 (0.088)*	
	Population density x 100,000	*-2.357 (0.043)*	*-3.073 (0.039)*		*-1.983 (0.077)*	*-3.966 (0.014)*	*-3.419 (0.006)*	*-13.951 (0.005)*		*-26.972 (0.030)*	*-16.311 (0.003)*	*-9.396 (0.087)*	*-30.512 (0.039)*
	Median income x 10,000	*-0.309 (0.024)*	*-0.403 (0.023)*	*-0.237 (0.057)*	*-0.323 (0.016)*	*-0.362 (0.058)*	*-0.317 (0.030)*						
	Inter-decile income ratio								*-0.303 (0.024)*			*-0.264 (0.059)*	
	Among those 65 and older, enrolled in ASPA												*0.379 (0.049)*
	Non-workforce participants in the working age population (%)									*-11.772 (0.085)*			*-15.593 (0.058)*
	For-profit surgical bed supply per capita x 1,000	**-7.128**	**-13.610**	*-2.415 (0.073)*	**-6.560**	**-13.673**	*-1.106 (0.053)*	**-18.069**	**-18.758**	**-28.107**	**-18.510**	**-18.342**	*-24.699 (0.002)*
	Not-for-profit bed supply per capita x 1,000	**6.175**	**11.651**	*2.684 (0.016)*	**5.954**	**12.719**	*-3.947 (0.013)*	**13.543**	**13.634**	*11.812 (0.028)*	**15.999**	**14.824**	*11.865 (0.065)*
	Spatial lag term	**0.379**			**0.506**			*0.303 (0.007)*			*0.294 (0.008)*		
	LR statistic of spatial dependence test	*10.626 (0.001)*			**21.594**			*7.792 (0.005)*			*7.237 (0.007)*		
	Model adjusted r-square	0.447	0.545	0.135	0.528	0.533	0.245	0.303	0.505	0.263	0.519	0.496	0.223

How for-profit and not-for-profit hospitals differ in providing care for a broader set of elective surgeries

FP hospitals provide more elective surgeries, with a shorter LOS, but with greater recorded comorbidities

			Demographics			
	Type	N	Age	LOS	2° dx	Male
Tonsillectomy	NFP	45,637	4.8	0.83	0.85	56.2
	FP	98,571	4.6	0.63	**0.73**	56.9
PCI	NFP	59,863	66.5	3.58	3.56	76.5
	FP	52,835	67.6	3.48	**3.51**	76.9
Cholecystectomy	NFP	52,284	52.0	3.28	1.08	28.3
	FP	56,451	52.0	3.16	1.12	28.1
Hysterectomy	NFP	34,921	51.6	4.87	1.56	0.0
	FP	32,692	52.5	**5.05**	1.97	0.0
CEA	NFP	11,027	71.6	5.65	4.11	71.9
	FP	12,332	72.3	5.31	4.37	71.8
Hip replacement	NFP	57,979	68.2	9.36	1.99	45.5
	FP	89,935	69.1	8.84	2.35	45.8
Knee replacement	NFP	44,563	70.5	9.71	2.52	34.3
	FP	69,711	70.9	9.40	2.93	36.6
TURP	NFP	30,365	71.1	5.56	1.93	100.0
	FP	50,280	70.9	5.44	2.38	100.0
Radical prostatectomy	NFP	5,232	63.2	8.70	1.50	100.0
	FP	9,874	63.6	**8.81**	2.32	100.0
Spine surgery	NFP	23,530	47.6	5.20	1.47	56.8
	FP	45,027	47.3	4.38	1.72	57.6

FP hospitals are reimbursed more for physician services, but less overall

		Reimbursement (€)			
	Type	Physician	Structural	Clinical & direct	Total
Tonsillectomy	NFP	26	34	899	959
	FP	206	38	348	592
PCI	NFP	92	100	4732	4923
	FP	1561	91	3701	5353
Cholecystectomy	NFP	59	84	3109	3251
	FP	673	94	1499	2266
Hysterectomy	NFP	18	118	4089	4225
	FP	728	151	2246	3126
CEA	NFP	153	173	5834	6160
	FP	1627	148	3125	4900
Hip replacement	NFP	113	217	7406	7736
	FP	1239	295	5136	6669
Knee replacement	NFP	168	220	8717	9105
	FP	1340	289	6319	7949
TURP	NFP	96	146	3339	3581
	FP	761	165	1700	2626
Radical prostatectomy	NFP	220	196	6961	7377
	FP	1558	238	3525	5320
Spine surgery	NFP	35	149	4348	4532
	FP	730	132	1916	2777

A quick point of explanation for the next slides

GHM	FP	NFP
Niveau 1	70,000	35,000
Niveau 2	20,000	10,000
Niveau 3	10,000	5,000

Relative rate of FP: NFP low = 1.0
Relative rate of FP: NFP high = 1.0

GHM	FP	NFP
Niveau 1	90,000	35,000
Niveau 2	5,000	10,000
Niveau 3	5,000	5,000

Relative rate of FP: NFP low = 1.15
Relative rate of FP: NFP high = 0.52

GHM	FP	NFP
Niveau 1	30,000	35,000
Niveau 2	50,000	10,000
Niveau 3	20,000	5,000

Relative rate of FP: NFP low = 0.56
Relative rate of FP: NFP high = 1.83

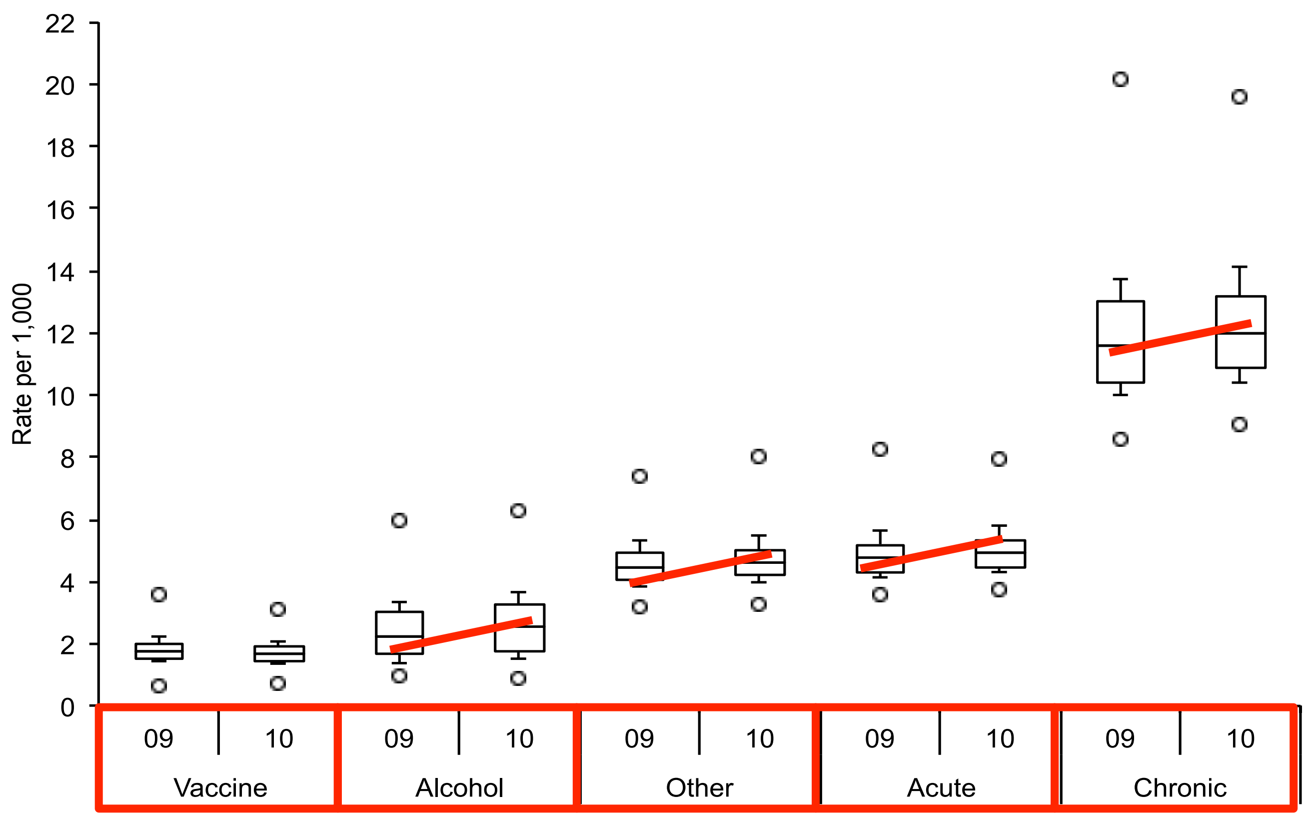
Evidence of lower admission thresholds or diagnostic over-coding in FP hospitals

			Relative rate at which FP hospitals admit for….	
			…the lowest reimbursement or complexity procedures	… the highest reimbursement or complexity procedures
Tonsillectomy		RR	**1.312**	**0.789**
	95% CI	Lower bound	**1.283**	**0.753**
		Upper bound	**1.342**	**0.837**
Cholecystectomy		RR	1.023	**0.831**
	95% CI	Lower bound	0.984	**0.800**
		Upper bound	1.063	**0.864**
Spine surgery		RR	1.015	**0.899**
	95% CI	Lower bound	0.968	**0.855**
		Upper bound	1.064	**0.945**
PCI		RR	0.979	**0.909**
	95% CI	Lower bound	0.951	**0.846**
		Upper bound	1.008	**0.977**

Potential evidence of upcoding in FP hospitals

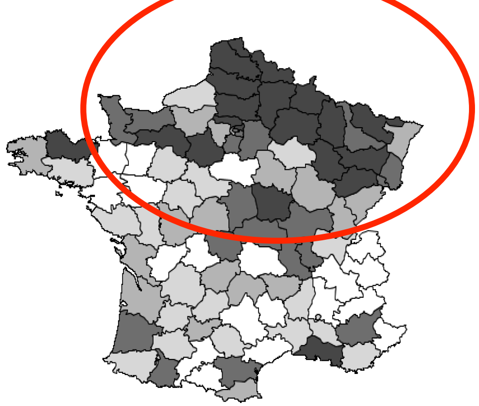
			Relative rate at which FP hospitals amit for …	
			…the lowest reimbursement or complexity procedures	…the highest reimbursement or complexity procedures
Hysterectomy		RR	0.968	**1.261**
	95% CI	Lower bound	0.925	**1.204**
		Upper bound	1.014	**1.321**
Hip replacement		RR	**0.949**	**1.106**
	95% CI	Lower bound	**0.929**	**1.058**
		Upper bound	**0.969**	**1.157**
Knee replacement		RR	**0.871**	**1.364**
	95% CI	Lower bound	**0.850**	**1.288**
		Upper bound	**0.892**	**1.445**
Radical prostatectomy		RR	0.931	**1.309**
	95% CI	Lower bound	0.856	**1.203**
		Upper bound	1.012	**1.423**

Geographic variation in rates of admission for ACSCs

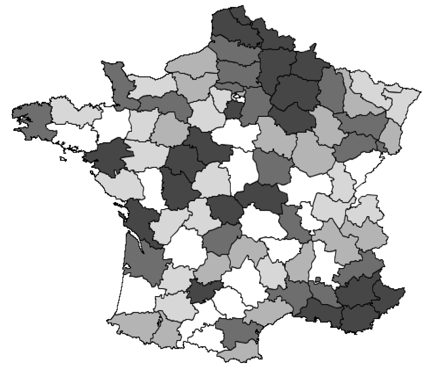


	Vaccine 09	Vaccine 10	Alcohol 09	Alcohol 10	Other 09	Other 10	Acute 09	Acute 10	Chronic 09	Chronic 10
National age-sex adjusted mean rate per 1,000	1.80	1.71	2.36	2.57	4.59	4.73	4.88	5.06	11.87	12.24
Lowest department rate per 1,000	0.61	0.74	0.99	0.92	3.17	3.29	3.59	3.71	8.60	9.04
Highest department rate per 1,000	3.56	3.11	5.99	6.28	7.41	8.00	8.22	7.93	20.18	19.57
Extreme ratio	5.82	4.20	6.07	6.81	2.34	2.43	2.29	2.14	2.35	2.16
Interquartile ratio	1.29	1.29	1.80	1.82	1.21	1.20	1.21	1.20	1.25	1.21
Coefficient of variation	0.22	0.21	0.40	0.41	0.16	0.16	0.16	0.15	0.16	0.15
Systematic component of variation (x10)	4.88	4.55	16.26	16.68	2.35	2.31	2.24	1.99	2.28	2.15

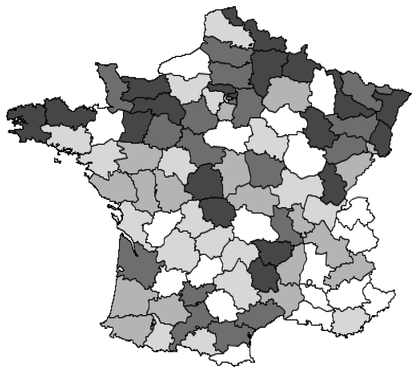
ACSC-specific regional patterns



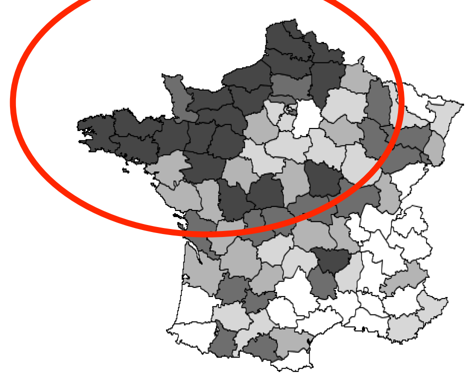
Chronic ACSCs



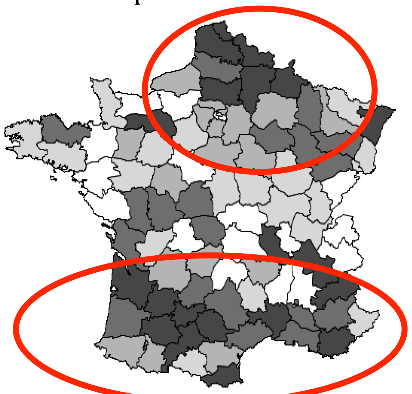
Acute ACSCs



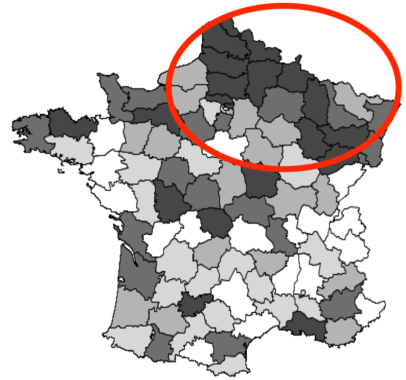
Vaccine preventable ACSCs



Alcohol related ACSCs



Other ACSCs



Total ACSCs

Higher admission rates for chronic, vaccine preventable, and alcohol related ACSCs with a greater bed supply

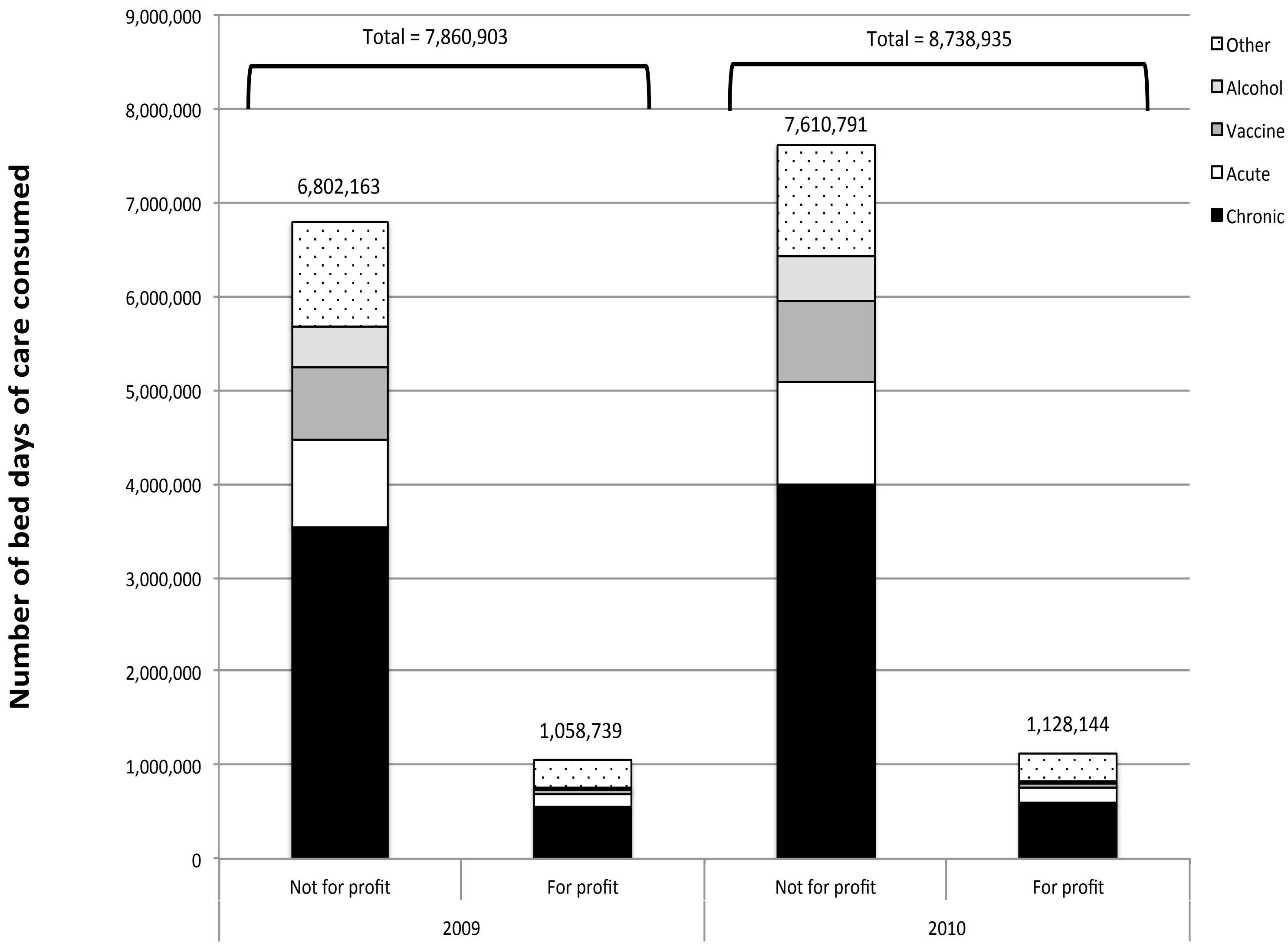
		Chronic	Acute	Vaccine preventable	Alcohol related	Other	Total
2009	Reallocated medical beds per capita	**1.959**	0.360 (0.053)	0.306 (0.007)	0.632 (0.003)	-0.017 (0.926)	**3.221**
	Reallocated general practitioners per capita	-0.063 (0.930)	0.496 (0.153)	-0.071 (0.731)	-1.026 (0.011)	0.539 (0.115)	-0.143 (0.911)
	Spatial lag term	**0.371**	0.230 (0.052)	0.223 (0.075)	**0.517**	**0.400**	**0.353**
	Likelihood ratio statistic of spatial dependence	**12.325**	3.931 (0.047)	2.828 (0.093)	**21.462**	10.711 (0.001)	10.526 (0.001)
	Model adjusted r-square	0.471	0.273	0.101	0.411	0.238	0.454
2010	Reallocated medical beds per capita	**1.734**	0.206 (0.286)	0.342 (0.001)	0.619 (0.005)	0.013 (0.944)	**2.851**
	Reallocated general practitioners per capita	0.423 (0.556)	0.696 (0.055)	-0.125 (0.512)	-0.895 (0.032)	0.698 (0.052)	0.741 (0.569)
	Spatial lag term	**0.350**	0.182 (0.135)	0.106 (0.420)	**0.557**	0.360 (0.001)	**0.393**
	Likelihood ratio statistic of spatial dependence	10.406 (0.001)	2.439 (0.118)	0.532 (0.466)	**26.289**	8.181 (0.004)	**12.802**
	Model adjusted r-square	0.456	0.251	0.119	0.458	0.209	0.451

Higher ACSC admission rates in France

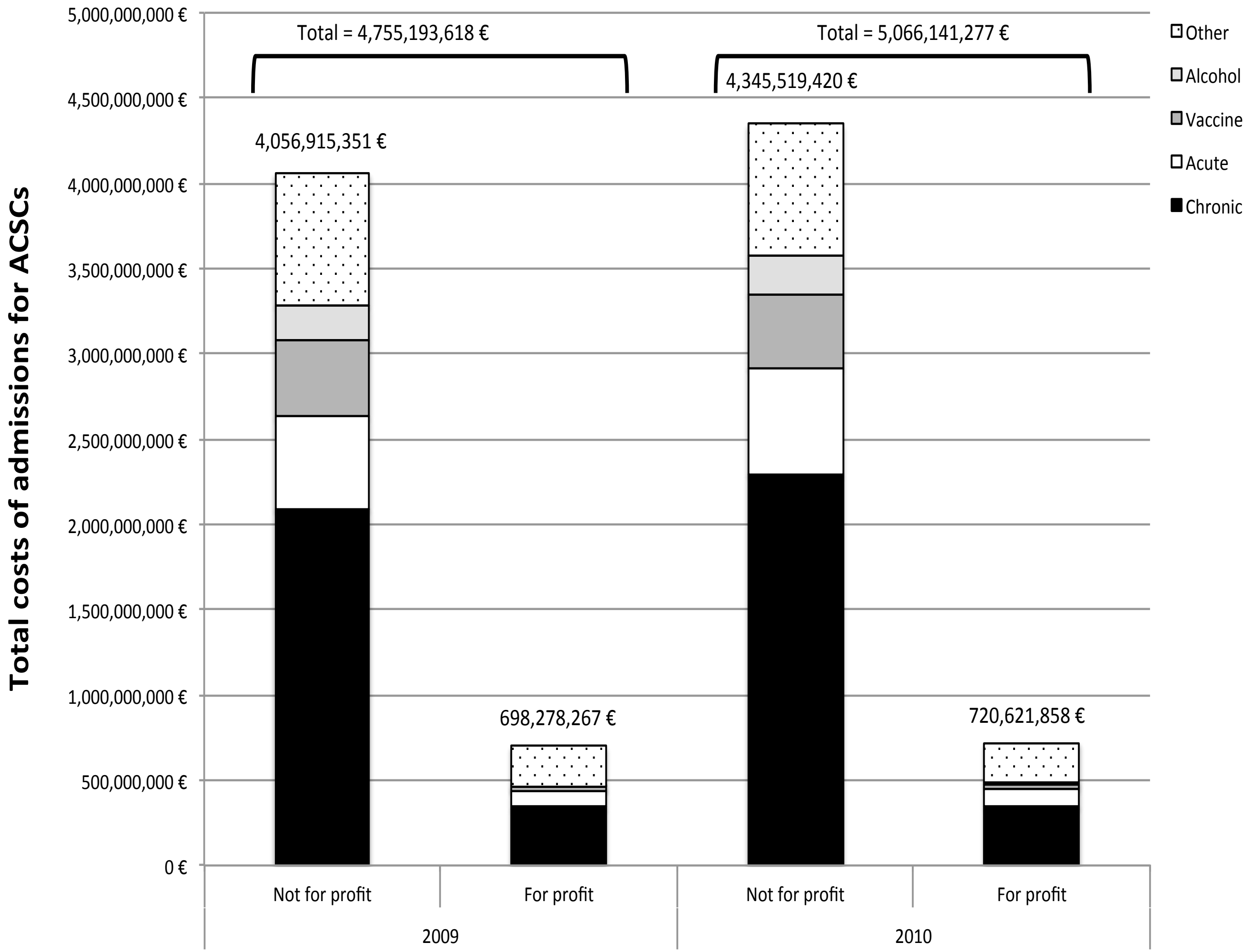
Country	Age group evaluated	Reported age-sex adjusted rate	Year calculated	Comparable rates in France	
				2009	2010
United Kingdom	<100	15.42	2009-10	**18.72**	
United States	65+	66.6	2010	47.07	49.4
Denmark	Varies according to ACSC type	9.34	2009	**10.82**	**11.17**
England		5.62			
Portugal		3.40			
Slovenia		6.19			
Spain		4.70			
Ireland	all	15.75	2008	**18.56**	**19.01**
Germany	all	6.68	2008	**9.44**	**9.75**
Brazil	<80	12.1	2008	5.44	5.51
France+	20+	10.17	2004-08	**11.39**	**11.92**
Canada	<75	3.51	2006-07	**7.51**	**7.58**
Switzerland:	<100	11.44'	2005-06	**18.56**	**19.01**
Spain^	65+	26.64'	2001-03	**34.06**	**36.25**
Italy@	20 - 64	2.61	2000	**4.88**	**4.97**
Australia~	all	5.15	2000	4.48	4.46
Singapore	all	2.94	1991-98	**7.40**	**7.66**

' Not age-sex adjusted.
~ Just Victoria was examined.
@ Just four cities were examined.
^ Just the environs of Madrid were examined.
+ Just three urban regions were examined.
: Data from four insurers were examined

ACSC admissions consume substantial bed days of care



ACSC admissions generate substantial reimbursements



Summary

- We found substantial geographic variation in rates of admission for common elective surgical procedures provided for treatment of preference sensitive conditions in France in 2009-2010
  - France had lower rates of most surgical admissions than the US, but measures of variation in use of surgical procedures were similar to, or higher than, those seen in UK and US.
- France exhibited less geographic variation in admissions for ACSCs, except for alcohol-related ACSCs where variation was quite high.
  - Such admissions consume substantial resources
  - France had relatively high rates of admission for ACSCs & they were increasing
- Admission rates for hip and knee replacement surgery were correlated with supply of sector-specific beds; those for several ACSCs were correlated with higher bed supply, but not general practitioner supply
- We found potential indications of overuse of care, overdiagnosis, and upcoding of procedures in the FP sector

Limitations

- Limited by the data we had.
  - These are initial, descriptive studies that, by design, were unable to determine causation but merely association.
- Used departments – other methods might be used.
- Unable to determine whether the interventions were 'justified'
- We did not have access to health status

Conclusions and policy recommendations

- Variation should be tracked and monitored for the purposes of quality improvement and monitoring efficient resource utilization
  - Interventions should be geographically targeted for greatest efficiency
  - They should be expanded to other conditions/treatments
  - ACSCs should be a priority
- Development of precise guidelines within France and internationally might reduce variation and improve efficiency
- Admission to for-profit and not-for-profit hospitals should be monitored
  - Monitor the FP sector for over-admission, over-diagnosis, and upcoding
  - Monitor both for supplier induced demand that could increase admission rates that, if large enough, could inadvertently offset cost savings achieved through lower per-admission costs.

Potential next steps

- Update with more recent years (in progress)
- Determine whether patients in high and low use regions have different preferences
  - perhaps by replicating Hawker's work that asked people who were deemed eligible for hip replacement if they wanted one, in a survey.
- Determine whether physicians in high and low use regions have different propensities to intervene
  - perhaps by replicating Sirovich's work wherein she compared physician responses to care vignettes.
- Implement shared decision making in a few high use regions, do not in others, and see if rates dropped in the ones with shared decision making.
- Use providers from low use regions to develop a guideline (for, say, prostatectomy or CABG), implement the guideline in high use departments and see whether rates dropped there.
- Generate reports, do academic detailing in high use regions, and see whether rates revert to the mean there.

Thanks!

Introduction to health services research and small area variation analysis

Offered Feb 22 – March 9

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Systematic component of variation

- Developed in 1982 by Klim McPherson to allow for comparison of the degree of geographic variation across countries
- Recognized that variance and standard deviation are influenced by the scale of measurement (because of floor effect).
- Recognized that coefficient of variation is influenced by underlying population size and will be large if sampling error is the dominant source of variation
- To provide supplement knowledge of the disparity between average rates with information on internal variation, SCV is adapted from proportional hazards model and estimates relative systematic component of variation by subtracting the random component of variance from the estimate of total variance

SCV methods

- We are trying to estimate variation around a regional norm, that allows for differences in prevailing rates and population denominators
- Calculate age- and sex- adjusted per-capita rates for geographic regions
- We know the observed number of incidents in a setting and the expected number – and these should be about the same if there's no variation.

$$Y_j = \log\left(\frac{O_j}{E_j}\right) \approx 0$$

$$E\left(Y_j^{\,2}\right) = \left(\frac{1}{E_j^{\,2}}\right) \text{Variance}\left(O_j - E_j\right)$$

$$E\left(Y_j^{\,2}\right) = \left(\frac{1}{E_j^{\,2}}\right) \left(E_j^{\,2}\sigma^2 + E_j\right)$$

$$E\left(Y_j^{\,2}\right) = \sigma^2 + \left(\frac{1}{E_j}\right)$$

$$\left(\sum_{j=1}^{k} \frac{Y_j^2}{k}\right) = \sigma^2 + \frac{1}{k}\sum_{j=1}^{k}\frac{1}{E_j}$$

$$\hat{\sigma}^2 = \left(\sum_{j=1}^{k} \frac{Y_j^2}{k}\right) - \frac{\sum_{j=1}^{k}\frac{1}{E_j}}{k}$$

$$\text{area dependent component (SVC)} = \text{observed variance} - \text{random component}$$

Spatial regression analysis

- Tobler's Law: there is spatial autocorrelation in a variable if observations that are closer to each other have related values.
- If there is such autocorrelation, the assumption of independence of variables is violated
- Test for autocorrelation using non-spatial regression residuals and a spatial proximity matrix for weighting when calculating Moran's I, for determination of whether spatial dependencies are significant.
- If they are, use spatial regression model
- These include a spatial lag term that specifies values at nearby locations and is included in the regression
- Spatial proximity weight matrices:
  - Contiguity based: Queen (uses all common points); Rook (uses only common boundaries)
  - Distance based: Baricentric distance; main cities distance