Financial Incentives and Competitive Pressure: The Case of the Hospital Industry

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Activity-based funding of public hospitals

> *The only thing that matters today is to perform even more procedures, to have more patients, to make more money.*
>
> Pr. Stéphane Dauger
> Head of pediatric critical care unit, Hôpital Robert-Debré, Paris

Activity-based payment (a.k.a. "T2A")

- Similar to Prospective Payment System (PPS) used in most developed countries
- Has become the *bête noire* of public hospitals in France

Before the reform: Lump-sum payment did not respond to activity

- Little incentives to compete with other (private or public) hospitals

After the reform: Revenue is linear in number of performed procedures

- T2A criticized for creating excessive incentives to compete for patients
- Managers require more effort from staff

Policy debate

Critics

- Excessive incentives to compete
- Causing "activity race" (T2A called "inflationary")
- Pressure on managers, passed on to medical staff
- Managers and staff complain, particularly in the public nonprofit sector
- In 2017, presidential candidate Macron proposed to cap T2A to 50% of total revenue

Difference with Medicare reform in the 80'

- Pre-reform rule was Cost-Plus in the US, Global Budgeting in France
- Cutler (1995), Acemoglu and Finkelstein (2008): Cost plus $\longrightarrow$ Price cap
- Here: Global budgeting (lump-sum) $\longrightarrow$ T2A (PPS, variable payment)

Estimating causal effect of the introduction of T2A in the nonprofit sector

Over the phase-in period of the reform: 2005 to 2008

Quantifying implicit "effort" associated with increased competitive pressure

- Effort: all pecuniary and non-pecuniary costs
- Has T2A caused the overall number of surgery procedures to rise? Or only business stealing?

Breaking down observed evolution of activity

- Effect of T2A, demand and supply shocks
- Effect on patient surplus?

Estimating a structural model of competition in utility

Hospitals modeled as supplying utility directly to patients

- Heterogeneity in hospitals' objective functions
- Hospital preferences depend on the number of admitted patients and on the average utility provided
- Marginal costs allowed to depend on the utilities provided to patients

Identification of hospital preferences

- Assumption: Costs and preferences are stable over time
- The introduction of T2A provides an exogenous change

Preview of results 1/2

From demand and supply estimation

- Strong heterogeneity in hospital attractiveness
- Financial incentives account for less than 10% of marginal incentives to attract patients
- Private hospitals more responsive to incentives
- Strategic complementarity (with intensity decreasing with distance)
- Intra-sector competition tends to be fiercer than inter-sector competition

Preview of results 2/2

Reference: 2005. Counterfactual 2005 with full T2A incentives as in 2008 (8 diagnosis categories)

Activity and market shares

- Activity grows in the nonprofit sector by 3%–14%
- Activity declines in the profit sector by 1%–5%
- Market share of nonprofit sector grows by 1pp-4pp
- Total activity grows by .3%–2.4% (observed activity rises mostly explained by demand shocks)
- Main causal effect of T2A is business stealing from for-profit sector

Patients' gains equivalent to a 2%–15% reduction in travel time

Nonprofit hospitals much worse off under T2A than under global budgeting

- Additional effort equivalent to about one quarter of a full-year activity-based revenue

Hospital choice

Ho, 2006; Ho and Pakes, 2014; Gowrisankaran, Nevo, and Town, 2015; Gaynor, Propper, and Seiler, 2016; Ho and Lee, 2017; Garmon, 2017; Raval, Rosenbaum, and Tenn, 2017; Barrette, Gowrisankaran, and Town, forthcoming; Raval and Rosenbaum, forthcoming

Non-price competition in healthcare

Eliason (2017), Hackmann (2019)

Financial incentives and hospital legal status

Duggan, 2000, 2002; Gaynor and Vogt, 2003; Lakdawalla and Philipson, 2006

Structural econometrics

Peters (2006), Björnerstedt and Verboven (2016), Bonnet and Dubois (2018), Berry (1994), Berry, Levinsohn and Pakes (1995), Verboven (1996), Huang, Rojas, et al. (2013) and Huang and Rojas (2014) Dubois and Lasio (2018).

Road map

- Data and Funding Reform
- Demand
- Supply
  - Identification
- Results
  - Demand
  - Supply
  - Breaking down of activity
  - Role of financial incentives
- Conclusion

Two sectors defined by ownership and legal status

"Nonprofit sector" (NP): 423 state-owned or private nonprofit hospitals

- 52% of surgery bed capacity
- 353 state-owned hospitals
- 70 private, nonprofit hospitals

"For-profit sector" (FP): 519 private for-profit clinics

- 48% of surgery bed capacity

Introduction of activity-based payment in the nonprofit sector

r_{Djt}: Rate paid by government to hospital j at year t for an admission in DRG D

For-profit clinics: Already under ABP in 2005

$r_{Djt} = \bar{r}_{Dt}^{\mathrm{FP}}$

Nonprofit sector: Phase-in between 2005 and 2008

- Share of revenue based on activity increased gradually
- Starting point (2004): Global budgeting (zero revenue from activity)
- Phase-in step function:

$$
\begin{aligned}
r_{Dj2005} &= 0.25 \quad \bar{r}_{Dt}^{\mathrm{NP}} \\
r_{Dj2006} &= 0.35 \quad \bar{r}_{Dt}^{\mathrm{NP}} \\
r_{Dj2007} &= 0.5 \quad \bar{r}_{Dt}^{\mathrm{NP}} \\
r_{Dj2008} &= \quad \bar{r}_{Dt}^{\mathrm{NP}}
\end{aligned}
$$

- Decrease of lump-sum transfers to neutralize impact on revenue

Identification supply

Data

All surgery admissions between 2005 and 2008

- Surgery care
- 8 major diagnosis categories g: orthopedics, ENT-stomatology, ophthalmology, gastroenterology, gynaecology, dermatology, nephrology circulatory system
- account for 21 million surgery admissions out of 23 million over the period of study
- Period of study: $t = 2005$ to $t = 2008$
- 37,000 patient locations z (mainland France)

Table 1: Summary statistics

	mean	s.d.	min	p10	p25	median	p75	p90	max
# of inhabitants	2,126	8,941	68	202	312	605	1,370	3,492	439,374
# of stays	20.27	94.54	1	1	2	5	13	34	10,393
# of hospitals	4.04	5.13	1	1	2	3	5	7	147
# of observations (g, t, z)					885,421				

Source. French PMSI, individual data, 2005-2008.
Sample. 942 hospitals in mainland France.
Note. Observations at the diagnosis category × year × postal code level (17,945,047 discharges).

Data

Data sources

- Programme de Médicalisation des Systèmes d'Information (PMSI)
- Statistique Annuelle des établissements de santé (SAE)
- *Arrêtés* published in the *Journal Officiel* for DRG rates
- The classification algorithm (v10c version) of DRGs remained identical over 2005-2008

Distances

- All distances in the paper are based on the center of the corresponding postal codes
- Travel time by road
- The median travel time is 22 minutes, the interquartile range being quite large (9.5,36.5)

Reimbursement rates at the diagnosis category level

$$r_{gjt} = \frac{\sum_{D \in g_t} r_{Djt} q_{Djt}}{\sum_{D \in g_t} q_{Djt}}$$

- Composition effects due to specialization or to coding strategies (Dafny, 2005; Gowrisankaran, Joiner, and Lin, 2019) are second order to quadrupling of rates in the NP sector
- Affect counterfactual exercises very little

Table 2: Hospitals' reimbursement rates (in €)

	2005	2006	2007	2008
Nonprofit hospitals	770	1,053	1,501	2,817
For-profit hospitals	1,032	1,021	1,033	1,018

Note. Average reimbursement rates r_{gjt}.

Source. French PMSI, individual data.

Sample. 942 hospitals in mainland France.

Evolution of surgery admissions

5m admissions per year

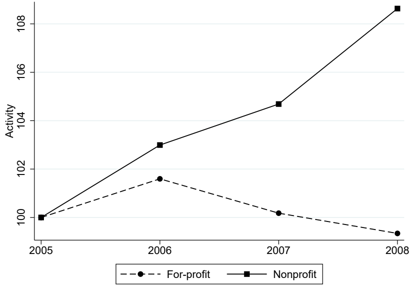


Figure 1: Number of surgery admissions in mainland France (by legal status)

- Aggregate market share of NP hospitals rose from 37.4% to 39.5%
- Differential trends across NP and FP sectors remain apparent after controlling for hospital-diagnosis and diagnosis category-year effects
- Almost unchanged parameters when control also for staff, equipment and sociodemographic variables

Hospital choice

Assume patients with similar characteristics have same choice proba.

- Garmon (2017), Raval, Rosenbaum, and Tenn (2017); Barrette, Gowrisankaran, and Town (forth.), Raval and Rosenbaum (forth)
- Patient admissions grouped based on characteristics: major diagnosis categories, patient locations, age brackets (robustness check)

Nested Logit with 3 nests n (NP hospitals, FP hospitals, outside good)

- Utility of patients in group i undergoing surgery at hospital j and date t

$$U_{ijt} = \delta_{ijt} + \zeta_{int} + (1 - \sigma)\varepsilon_{ijt} \qquad 0 \leq \sigma < 1$$

- with mean utility level offered to patients in group i

$$\delta_{ijt} = u_{jt} - \text{TC}(d_{ij}; X_{it}) + \gamma \ \text{NP}_j \ X_{it} + \varphi_{it} + \xi_{ijt}. \tag{1}$$

- Travel costs TC
- u_{jt} and φ_{it} are parameters to be estimated
- Disturbances ξ_{ijt}: deviations from mean attractiveness of hospital j

Identification and estimation

Demand is estimated separately in each of the 8 clinical departments

Estimating equation (Berry, 1994)

$$\log \frac{s_{ijt}}{s_{i\emptyset t}} = u_{jt} + \alpha_0 \text{Closest}_{ij} - \alpha_1 d_{ij} - \alpha_2 d_{ij}^2 - \alpha_{1X} d_{ij} X_{it} + \gamma \text{NP}_j X_{it} + \varphi_{it} + \sigma \log s_{ijt|n} + \xi_{ijt}$$

Outside option: all non-surgery treatments with or w/o hospitalization

- To approximate potential demand, we adapt Huang, Rojas, et al. (2013), Huang and Rojas (2014), Dubois and Lasio (2018)
- Minimize distance b/w models with and w/o patient group indicators φ_{it}

Instruments Z_{jtz}^D for within shares

$$\mathbb{E}\left[\xi_{ijt} \mid it, jt, d_{ij}, d_{ij} X_{it}, \text{NP}_j, Z_{ijt}^D\right] = 0$$

- Sum of (squared) distances to other hospitals in the same nest
- Minimum distance between patient location and other hospitals in the same nest
- Interaction with sociodemographics

Identification and estimation

Two-way fixed effects $u_{jt} + \varphi_{it}$

- Abowd, Kramarz, and Margolis (1999)
- Identification of utilities requires connections between hospitals

$$u_{jt} + \varphi_{it} \;\rightarrow\; (u_{jt} - C_t) + (\varphi_{it} + C_t)$$

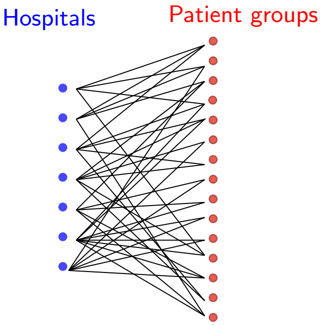
One normalization condition per connected component (year $\times$ diagnosis)

$$\sum_z \text{degree}(z)\ \varphi_{it} = 0$$

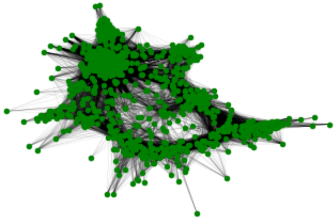
- degree(z) = Number of hospitals receiving patients from zipcode z
- Aggregate demand is allowed to vary over time
- u_{jt} is identified up to additive constant C_t ($u_{jt} + \varphi_{it}$ is identified)
- Normalization plays no role in counterfactual simulations

Bipartite network and hospital graph

One connected component for each year × diagnosis category



(a) Bipartite network



(b) Hospital graph (Orthopedics, 2008)

The graph is strongly locally connected. For instance, for orthopedics in 2008, 90% of hospitals are connected to more than 37 patient groups

For each diagnosis category, hospital objective functions is

$$V_{jt}(q_{jt}, u_{jt}; r_{jt}) = \bar{T}_{jt} + r_{jt}q_{jt} + \beta^{q}_{jt}\ q_{jt} + \beta^{qu}_{jt}\ q_{jt}\ u_{jt}$$

Quasilinear in revenue $\bar{T}_{jt} + r_{jt}q_{jt}$

- r_{jt}: Rate per admission; $\bar{T}_{jt}$: Lump-sum transfer
- Marginal utility of revenue normalized to 1

Non-revenue part $\beta^{q}_{jt}\ q_{jt} + \beta^{qu}_{jt}\ q_{jt}u_{jt}$

- u_{jt} is the utility provided by the hospital
- Costs contribute negatively to β^{q}_{jt} and β^{qu}_{jt}
  - Constant returns to scale $q(r + \beta^{q} + \beta^{qu}u)$
  - If $\beta^{qu}_{jt} < 0$, raising utility implies higher *variable* costs
- Altruism and empire building contribute positively to β^{qu}_{jt} and β^{q}_{jt}

For any diagnosis category and year, hospital j chooses u_{jt} to solve

$$\max_{u_{jt}} V_{jt}(q_j(u_{jt}, u_{-jt}), u_{jt})$$

First-order conditions

$$r_{jt} + \beta_{jt}^{q} + \beta_{jt}^{qu} u_{jt} = -\frac{\beta_{jt}^{qu}}{\eta_{jjt}}$$

- where $\eta_{jjt} = \partial \ln q_{jt} / \partial u_{jt}$ semi-elasticity
- Second-order conditions empirically checked

The hospital incentives in equilibrium

Hospital objective: $V(q,u) = q(r + \beta^q + \beta^{qu} u)$

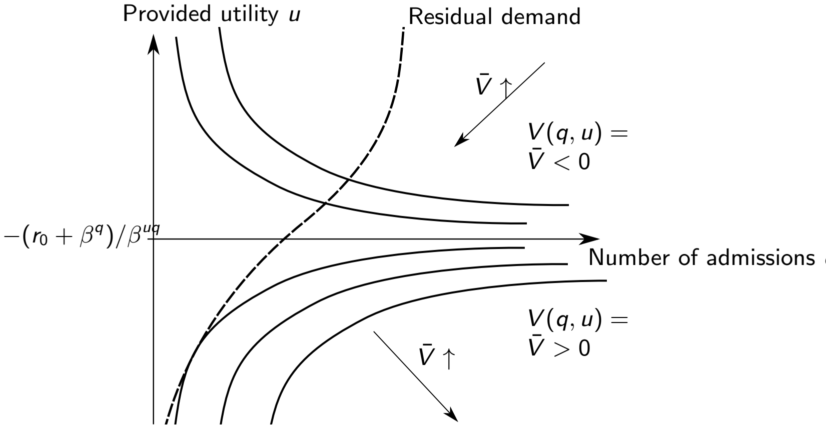


Figure 2: Hospital problem (given utilities provided by competitors)

From first-order conditions, hospitals respond to an increase in r_{jt} by changing the utilities provided to patients by

- Transmission rate

$$\tau_{jt} = \left.\frac{\partial u_{jt}}{\partial r_{jt}}\right|_{u_{-jt}} = -\left(\beta_{jt}^{qu}\left[2 - \frac{q_{jt}\,\partial^2 q_{jt}/\partial u_{jt}^2}{\left(\partial q_{jt}/\partial u_{jt}\right)^2}\right]\right)^{-1}$$

- Second-order conditions are equivalent to positive transmission rates

Transmission of an increase in DRG rates r

Keeping the other hospitals' utilities fixed

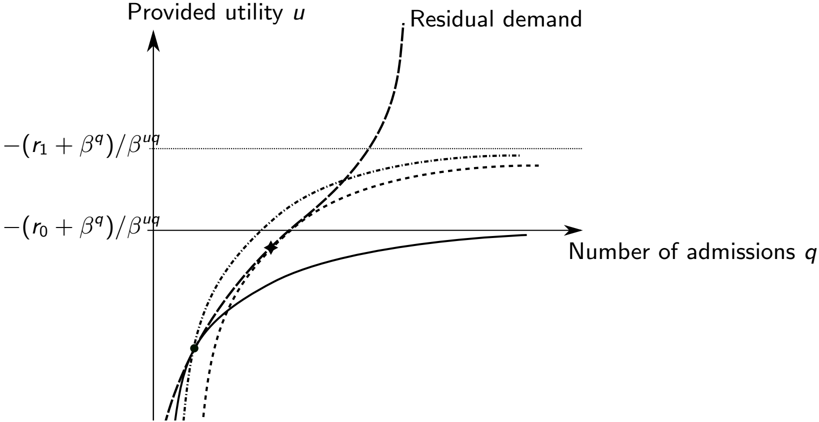


Figure 3: Increasing r from r_0 to $r_1 > r_0$ makes iso-V curves flatter: q and u increase

Slopes of reaction functions: The nature of strategic interactions

$$\rho_{jkt} = \left.\frac{\partial u_{jt}}{\partial u_{kt}}\right|_{r_{jt}} = \frac{q_{jt}(\partial^2 q_{jt}/\partial u_{jt}\partial u_{kt}) - (\partial q_{jt}/\partial u_{jt})(\partial q_{jt}/\partial u_{kt})}{2(\partial q_{jt}/\partial u_{jt})^2 - q_{jt}(\partial^2 q_{jt}/\partial u_{jt}^2)}$$

Total effect of an increase in financial incentive

Hospitals' response in utility is given by

$$\mathrm{d}u_t = L_t \tau_t \mathrm{d}r_t$$

where the Leontief matrix $L_t = (I - \rho_t)^{-1}$ reflects propagation through competitive interactions

Identification of hospital incentives

Separate identification and estimation for each of the 8 clinical departments (index g omitted)

Identification

- Contrary to price competition models: two "grand" coefficients to be identified, β^{q}_{jt} and β^{qu}_{jt}

Identifying restrictions

- Preferences remain constant over the years 2005-2008

$$\beta^{q}_{jt} = \bar{\beta}^{q}_{j} + \omega_{jt} \quad \text{and} \quad \beta^{qu}_{jt} = \bar{\beta}^{qu}$$

- where $\bar{\beta}^{q}_{j}$ are hospital effects, ω_{jt} are "supply shocks", and $\bar{\beta}^{qu}$ is the same coefficient for all j

Identification of hospital incentives

Rewriting first-order condition

$$u_{jt} + \frac{1}{\eta_{jjt}} = -C_t - \frac{\bar{\beta}^q_j}{\bar{\beta}^{qu}} - \frac{r_{jt}}{\bar{\beta}^{qu}} - \frac{\omega_{jt}}{\bar{\beta}^{qu}}$$

- $\bar{\beta}^{qu}$ identified
- $\bar{\beta}^q_j$ and C_t identified up to an additive constant

Yields identification of

- Incentives to attract an extra patient: $r_{jt} + \bar{\beta}^q_j + \bar{\beta}^{qu} u_{jt}$
- Transmission rates τ_{jt}
- Slopes of reaction functions ρ_{jkt}

Exclusion restrictions

Estimating equation

$$u_{jt} + \frac{q_{jt}}{\partial q_{jt} / \partial u_{jt}} = a_t + a_j + a_r r_{jt} + \omega'_{jt}$$

Identification assumption

$$\mathbb{E}(\omega'_{jt} \mid j, t, Z_{jt}) = 0$$

with

$$Z_{jt} = \text{Phase-in step function}_t \times NP_j$$

Phase-in step function

Demand results

- Parameters are precisely estimated
- Most of the variance captured by the two-way fixed-effects
- Tests for excluded instruments have high F-stats
- Simple Logit model rejected at usual levels
- Preference for being admitted to closest hospital as well as diminishing marginal travel costs
- Travel costs decrease with income and are higher in more crowded areas
- Richer patient location prefer for-profit hospitals
- Areas with more educated people favor nonprofit hospital or are indifferent

Table 3: Demand

	Circulatory system	Nephrology	Dermatology	Gynaecology	Gastroenterology	Ophthalmology	ENT, Stomatology	Orthopedics
Travel cost (α)								
Closest hospital (α_0)	0.124***	0.155***	0.250***	0.161***	0.217***	0.137***	0.154***	0.178***
	(0.014)	(0.014)	(0.014)	(0.012)	(0.013)	(0.013)	(0.013)	(0.011)
Time (α_1)	0.168***	0.231***	0.146***	0.236***	0.336***	0.304***	0.307***	0.411***
	(0.021)	(0.022)	(0.018)	(0.016)	(0.018)	(0.022)	(0.019)	(0.013)
Time^2 $\times$ 100 (α_2)	-2.171***	-2.428***	-2.486***	-2.331***	-3.187***	-2.306***	-2.973***	-2.703***
	(0.080)	(0.098)	(0.083)	(0.076)	(0.089)	(0.091)	(0.104)	(0.070)
Time $\times$ High school	-0.015	-0.019	-0.029*	-0.042***	-0.093***	-0.072***	-0.047***	-0.081***
	(0.019)	(0.019)	(0.015)	(0.014)	(0.016)	(0.016)	(0.016)	(0.013)
Time $\times$ Elder	0.197***	0.199***	0.211***	0.171***	0.233***	0.206***	0.161***	0.198***
	(0.021)	(0.020)	(0.018)	(0.016)	(0.018)	(0.022)	(0.020)	(0.013)
Time $\times$ Income $\times$ 10^3	-0.006***	-0.006***	-0.005***	-0.004***	-0.003***	-0.003***	-0.005***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Time $\times$ Population $\times$ 10^5	0.085***	0.072***	0.068***	0.081***	0.057***	0.066***	0.066***	0.046***
	(0.006)	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)
Time $\times$ Women	0.566***	0.543***	0.660***	0.519***	0.583***	0.429***	0.648***	0.377***
	(0.039)	(0.044)	(0.043)	(0.032)	(0.035)	(0.041)	(0.043)	(0.023)
Preference for nonprofit hospitals (γ)								
Nonprofit $\times$ High school	-0.098	0.140	-0.005	0.152	0.082	0.466**	-0.030	0.154**
	(0.100)	(0.104)	(0.091)	(0.117)	(0.080)	(0.212)	(0.101)	(0.071)
Nonprofit $\times$ Elder	0.149*	0.113	0.134	0.269***	0.091	0.169*	0.629***	-0.105*
	(0.088)	(0.088)	(0.091)	(0.104)	(0.075)	(0.097)	(0.094)	(0.060)
Nonprofit $\times$ Income $\times$ 10^3	-0.015***	-0.011**	-0.022***	-0.021***	-0.017***	-0.044***	-0.035***	-0.016***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.006)	(0.005)	(0.003)
Nonprofit $\times$ Women	-0.714***	0.314	0.251	0.569***	0.844***	-0.182	-0.241	-0.021
	(0.203)	(0.235)	(0.203)	(0.204)	(0.156)	(0.275)	(0.220)	(0.158)
σ	0.131***	0.171***	0.176***	0.108***	0.154***	0.159***	0.137***	0.206***
	(0.018)	(0.022)	(0.018)	(0.019)	(0.016)	(0.022)	(0.023)	(0.016)
# of hospital-year FE	3,516	3,412	3,720	3,560	3,608	3,088	3,552	3,680
# of postal code-year FE	100,696	105,431	103,643	108,983	115,949	115,190	114,286	121,243
# of connected components	5	5	4	4	4	5	5	4
Observations	308,600	332,805	354,033	430,943	447,437	440,989	466,121	795,638

Source. French PMSI, individual data.
Robust standard errors clustered at the hospital level.
Note. Covariates interacted with Nonprofit are centered.
For the sake of readability, "time" has been divided by 10.

Estimated utilities

Interquartile ranges for estimated utilities vary from .5 to 1.1

- On average, adding .1 to utilities is equivalent to reducing travel times by 11%-15%
- Substantial heterogeneity in attractiveness

Estimated utilities evolve as observed number of admissions

- Utilities increase more rapidly in nonprofit hospitals than in for-profit ones
- Same if control also for staff, equipment (caution needed) and socio-demographic variables

Estimated utilities $\hat{u}_{gjt}$

Table 4: Estimated utilities: reduced-form evidence

Dependent variable	$\hat{u}_{jt} \times 10^3$		
	(1)	(2)	(3)
Nonprofit × 2006	28.58***		29.53***
	(6.57)		(6.59)
Nonprofit × 2007	54.21***		55.37***
	(8.22)		(8.23)
Nonprofit × 2008	79.39***		81.07***
	(9.41)		(9.32)
Beds		0.41	0.75
		(0.57)	(0.58)
$Beds^2/1000$		-0.45	-0.50
		(0.43)	(0.44)
Nurses		0.13***	0.08*
		(0.05)	(0.04)
Surgeons		1.79**	0.78
		(0.76)	(0.57)
Anesthesiologists		0.76	0.85
		(1.25)	(0.97)
Staff		-0.04	-0.03
		(0.02)	(0.03)
MRI		-5.30	-10.15
		(9.76)	(9.39)
Scanner		-3.58	-2.38
		(4.96)	(4.77)
Population density		0.15***	0.17***
		(0.04)	(0.04)
Income		0.01**	0.02**
		(0.01)	(0.01)
Diagnosis category-year FE	Yes	Yes	Yes
Diagnosis category-hospital FE	Yes	Yes	Yes
Observations	28,136	28,136	28,136
R^2	0.955	0.955	0.955

Observations: diagnosis category × hospital × year level.
Robust standard errors clustered at the hospital level.
Population density and income measured at the *département* level.

Approximation of potential demand M_{it}

Market size represents .6%–2.5% of the population

- Potential number of admissions is .7%–12.4% larger than maximal number of annual admissions observed over 2005-2008

Table 5: Potential demand

	Circulatory system	Nephrology	Dermatology	Gynaecology	Gastroenterology	Ophthalmology	ENT, Stomatology	Orthopedics
$\hat{\theta} \times 10^3$	22	11	23	17	4	6	8	2
median maximal # of stays q_i	44	57	56	70	95	102	108	218
median potential demand M_i	49	61	63	76	97	105	112	220
median "mark-up" $100\frac{M_i - q_i}{q_i}$ (%)	12.4	5.6	12.3	8.5	1.8	2.7	3.6	0.7
median ratio $\frac{M_i}{\text{pop}_i}$ (%)	0.6	0.7	0.7	0.9	1.1	1.2	1.3	2.5
Obs.	29,996	30,186	30,146	30,321	30,430	30,423	30,403	30,464

Observations: postal codes (weighted by population).
Source. French PMSI, individual data, 2005-2008.
Sample. 942 hospitals in mainland France.

Supply equation

Providing a higher utility to each patient entails a higher marginal cost: $\bar{\beta}_{qu} < 0$

Table 6: Supply

	Circulatory system	Nephrology	Dermatology	Gynaecology	Gastroenterology	Ophthalmology	ENT, Stomatology	Orthopedics
OLS								
$r_{jt} \times 10^3$	-0.005	0.056	-0.083**	-0.046	0.055**	0.316*	0.007	0.114***
	(0.016)	(0.038)	(0.032)	(0.060)	(0.024)	(0.165)	(0.020)	(0.040)
R^2	0.424	0.202	0.454	0.291	0.143	0.509	0.117	0.101
IV								
$r_{jt} \times 10^3$	0.072***	0.028**	0.160***	0.058***	0.053***	0.054	0.071***	0.026***
	(0.018)	(0.013)	(0.017)	(0.011)	(0.009)	(0.039)	(0.022)	(0.009)
F-test excluded instrument	621.7	1,679.7	1,890.5	8,487.2	3,922.4	3,265.5	709.8	6,999.5
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,516	3,412	3,720	3,560	3,608	3,088	3,552	3,680

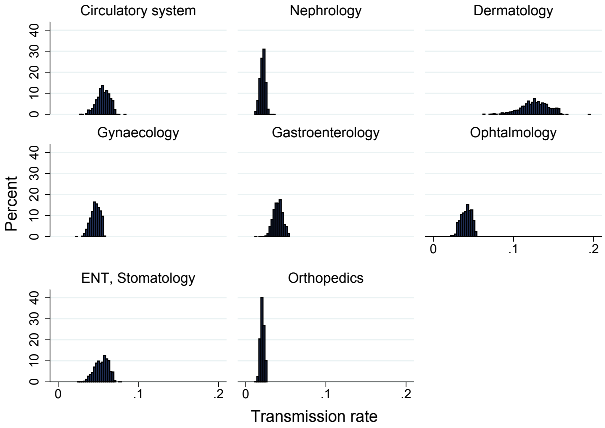
Robust standard errors clustered at the hospital level.
Excluded instrument: phase-in step function × NP.
The supply estimation is based on the estimated potential demand, see Table 5.

Share of the financial incentives created by the T2A in the total incentives

Median value of $r_{jt}/(r_{jt} + \beta_{jt}^{q} + \beta_{jt}^{qu} u_{jt})$ lies between 6% and 11%

Transmission of an increase in DRG rates r

Following a 1000€ shock on r, hospitals raise their utility by



- Equivalent to reducing median distance to patients by 3% and 18%
- All transmission rates are positive (second-order conditions satisfied)
- Among nonprofit hospitals, private ones are more responsive

Strategic interactions

- Reaction functions are upward-sloping
- For half of the observations (j, t), hospital j faces at least one competitor k for which ρ_{jkt} is higher than .07 at time t

Table 7: Slopes of reaction functions

	mean	s.d.	p1	p10	p25	median	p75	p90	p99	Obs.
$\bar{\rho}_{jt} = \max_k \rho_{jkt}$	0.078	0.054	0.002	0.015	0.036	0.069	0.108	0.149	0.237	28,132
nonprofit j - nonprofit k	0.039	0.038	0.002	0.006	0.012	0.028	0.054	0.086	0.181	12,629
for-profit j - for-profit k	0.058	0.045	0.002	0.011	0.024	0.047	0.083	0.119	0.210	15,489
nonprofit j - for-profit k	0.064	0.053	0.001	0.005	0.022	0.052	0.095	0.138	0.219	12,639
for-profit j - nonprofit k	0.054	0.052	0.001	0.007	0.017	0.036	0.075	0.125	0.230	15,486

Observations: diagnosis category $\times$ hospital $\times$ year level.
All (j, t) observations weighted by q_{jt}, at the exclusion of the four isolated connected components.

Table 8: The effect of distance on slopes of reaction functions

Dependent variable	Slope of reaction function ρ_{jkt}							
	Circulatory system	Nephrology	Dermatology	Gynaecology	Gastroenterology	Ophthalmology	ENT, Stomatology	Orthopedics
$d_{jk} \times 10^3$	-0.220***	-0.263***	-0.197***	-0.173***	-0.300***	-0.215***	-0.253***	-0.164***
	(0.007)	(0.008)	(0.005)	(0.005)	(0.009)	(0.008)	(0.008)	(0.004)
$d_{jk}^2 \times 10^6$	0.758***	0.872***	0.673***	0.542***	1.009***	0.602***	0.836***	0.470***
	(0.030)	(0.033)	(0.021)	(0.020)	(0.033)	(0.029)	(0.028)	(0.015)
Intra-sector$_{jk} \times 10^3$	0.475***	0.461***	0.365***	0.272***	-0.139*	0.752***	0.334***	0.218***
	(0.063)	(0.077)	(0.046)	(0.049)	(0.072)	(0.086)	(0.064)	(0.042)
# of year-hosp. j FE	3,515	3,411	3,720	3,560	3,608	3,087	3,551	3,680
# of year-hosp. k FE	3,515	3,411	3,720	3,560	3,608	3,087	3,551	3,680
Observations	210,118	237,222	332,238	286,348	340,968	212,930	307,602	516,524
R^2	0.276	0.259	0.226	0.250	0.200	0.219	0.209	0.178

Note. Intra-sector$_{jk}$ is defined as $NP_k NP_k + (1 - NP_j)(1 - NP_k)$.
Robust standard errors clustered at the hospital level.

The intensity of strategic interactions between two hospitals

- decreases (at a decreasing marginal rate) with their distance
- tends to be higher when the hospitals have same legal status

Breaking down the evolution of activity

- Financial incentives explain well Δs, but poorly Δq
- Patient group effects φ_{it}, socio-demographics X_{it}, and aggregate shocks C_t explain much of Δq
- Supply shocks do not matter much
- Competition reinforces the modest effect of incentives on Δq

Table 9: Breaking down activity variations: Orthopedics from 2005 to 2008

		(1)	(2)	(3)	(4)	(5)	(6)
		Δs^{NP} (pp)	$\Delta q/q$ All (%) total	$\Delta q/q$ NP (%) total	$\Delta q/q$ FP (%) total	$\Delta q/q$ NP (%) median	$\Delta q/q$ FP (%) median
	observed	**1.18**	**4.14**	**7.11**	**2.03**	**7.28**	**-1.24**
(a)	financial incentives	1.05	0.27	2.8	-1.53	2.44	-1.6
(b)	financial incentives (w/o strategic effects)	1.05	0.22	2.74	-1.57	2.35	-1.58
(c)	aggregate + hospital-specific demand shocks	0.18	3.88	4.33	3.56	3.1	2.01
(d)	**all but hospital-specific supply shocks**	**1.23**	**4.1**	**7.18**	**1.91**	**5.78**	**0.55**
(e)	hospital-specific supply shocks	0.29	0.09	0.78	-0.40	1.64	-1.3

These figures are based on the potential demand shown in Table 5.

Financial incentives: 1. Activity

Depending on diagnosis, financial incentives cause

- Total number of surgery admissions to increase by .3% to 2.4%
- Share of the nonprofit sector to increase by 1.1pp to 4.3pp

Example: For orthopedics

- Activity increases by 17,000 admissions in NP hospitals
- Activity decreases by 13,000 admissions in FP hospitals
- On the whole, only 4,000 patients more would undergo surgery due to T2A

Financial incentives: 2. Patients benefit from the reform

- Quantify rises in utility and equivalent reductions in travel times

Table 10: Impact of the reform on patients

	Median $\tilde{u} - \hat{u}$		Equivalent travel time reduction (%)		Obs.
	NP	FP	median	p90	
	(1)	(2)	(3)	(4)	(5)
Circulatory system	0.088	0.005	8.2	25.8	24,842
Nephrology	0.053	0.003	4.1	14.4	26,119
Dermatology	0.194	0.008	15.0	39.0	25,963
Gynaecology	0.094	0.004	6.5	19.1	27,248
Gastroenterology	0.141	0.012	10.6	31.6	28,914
Ophthalmology	0.066	0.003	2.7	9.7	28,507
ENT, Stomatology	0.073	0.004	3.5	12.5	28,612
Orthopedics	0.052	0.003	2.9	8.2	30,309

Observations: postal codes.
Counterfactual where $r_{j,2005}$ is multiplied by 4 in nonprofit hospitals.
$\tilde{u}$ (resp. $\hat{u}$) designates counterfactual (resp. estimated) utilities.

Financial incentives: 3. Hospitals are harmed

- Non-revenue part of objective function decreased by approx. activity-based revenue of 2005
- Hence additional effort caused by T2A equivalent to a quarter of full-year activity-based revenue

Table 11: Impact of the reform on nonprofit hospitals

	Activity-based revenues (€m)		Revenue part	Non-revenue part		Obs.
	observed (2005)	counterfactual	change (%)	change (%)	change (€m)	
	(1)	(2)	(3)	(4)	(5)	(6)
Circulatory system	62	284	358	-5.2	-65	406
Nephrology	109	454	316	-1.9	-106	395
Dermatology	64	294	362	-9.3	-82	421
Gynaecology	120	505	322	-3.5	-140	404
Gastroenterology	317	1,379	335	-6.8	-448	415
Ophthalmology	76	318	320	-2.1	-67	303
ENT, Stomatology	79	342	333	-3.0	-83	400
Orthopedics	445	1,836	313	-1.9	-480	417

Observations: nonprofit hospitals.
Note. Counterfactual where $r_{j,2005}$ is multiplied by 4 in nonprofit hospitals.
Lecture. In orthopedics, the reform increased by 313% activity-based revenues in the nonprofit sector.
Lecture. In orthopedics, the reform decreased by 1.9% the non-revenue part $\beta^{q}_{jt} q_{jt} + \beta^{qu}_{jt} q_{jt} u_{jt}$ of nonprofit hospitals.

Do financial incentives stimulate activity?

Robustness to size of potential demand

- Financial incentives have moderate effect on activity
- In general, less than 1% for the preferred approximated potential demand
- Higher if Potential demand = Entire Population (Column 5 below)

Table 12: How much do financial incentives explain the change in activity? Robustness wrt the size of potential demand

	observed change	change due to financial incentives			
θ		$0.5\hat{\theta}$	$\hat{\theta}$	$2\hat{\theta}$	1
Circulatory system	3.57	0.86	1.01	1.37	3.25
Nephrology	9.85	0.43	0.47	0.56	1.69
Dermatology	-5.49	2.05	2.36	3.21	7.12
Gynaecology	-2.07	0.66	0.77	1.05	3.2
Gastroenterology	1.86	0.98	1.02	1.15	4.47
Ophthalmology	9.04	0.25	0.27	0.3	1.1
ENT, Stomatology	-1.38	0.32	0.35	0.42	1.42
Orthopedics	4.14	0.26	0.27	0.28	1.32

Figures: relative change in activity from 2005 to 2008 (in %).

θ is the parameter governing potential demand: $\log(M_i) = \theta \log(\text{pop}_i) + (1-\theta)\log(q_i)$.

Concluding remarks (1/2)

T2A forced public hospitals to earn revenue from realized activity

- T2A made industry more competitive
- Increased managerial pressure, complaints, poor acceptability, etc.

Quantify extra effort nonprofit hospitals incurred to adjust

- Equivalent to about a quarter of a full-year activity-based revenue
- Order of magnitude stable across 8 major diagnosis categories
- Policy discussion needed to determine whether and how extra effort should be compensated

No empirical support for market expansion, i.e., for supposedly "inflationary" impact of T2A

- Nonprofit hospitals attracted patients who otherwise would have been admitted in for-profit hospitals

Concluding remarks (2/2)

Further research

- Identify consumer and provider preferences for both observed and unobserved product characteristics (here no observed product attributes)
- With longer observation periods, explore whether the effect of incentives can be identified separately from changes in the objectives of the hospitals
- Applicability to other industries (e.g., education, media, culture) where formerly protected public entities got exposed to competition from private players