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Innovative Procedures : The Key Factor for Hospital Performance

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The role of innovative procedures in the mortality gap between public and for-profit hospitals is investigated using a French exhaustive administrative dataset on patients admitted for heart attack. The more intensive use of innovative procedures by for-profit hospitals contributes largely to explaining the mortality gap. Public hospitals are found to perform better than for-profit hospitals when controlling for both the use of innovative procedures and patients' characteristics.

Keywords: hospital performance, innovative procedures, stratified duration model

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Introduction

In many countries, politicians and scholars debate on the extent to which hospital ownership status influences hospital performance. A wide literature has developed in the US to compare the performances of for-profit and not-for-profit hospitals (Sloan, 2000). In European countries, there usually coexist some for-profit hospitals which select their patients and some public hospitals which have to treat all patients.

For-profit hospitals run healthcare facilities as firms and each unit of disposable medical supply used for a procedure is fully reimbursed. By contrast, public hospitals have a restrictive global budget provided by the government and the total cost of disposable medical supplies is charged on this budget. This limits the number of supplies they can finance and they are often considered to be less efficient than for-profit hospitals.

In this paper, we study the mortality gap between public and for-profit hospitals in France for patients admitted for a heart attack.[3] We assess to what extent this gap can be explained by some differences in the use of innovative procedures.[4] Our empirical strategy relies on the estimation of a very flexible duration model with hospital-specific baseline hazards on a French exhaustive administrative dataset.

The literature is plagued by two types of selection issues. First, the type of insurance can vary across patients as in the US. A selection effect occurs if patients better covered by their insurance are admitted to a specific type of hospital. To overcome this issue, some studies focused on subsamples of patients with homogenous insurance (McClellan and Staiger, 2000). Others focused on countries where patients benefit from a universal coverage such as Taiwan (Lien, Chou and Liu, 2008). This is also the case in France.

A selection bias also appears when patients who are the sickest due to co-morbidities and secondary diagnoses tend to be admitted to some specific types of hospitals. In France, for-profit hospitals may refuse the sickest patients to maximize their profit (as in-death is costly and their reputation depends on their success statistics) whereas public hospitals have to treat them. Such selection bias is unlikely to appear in our study as we control for a wide range of secondary diagnoses.

[3] In France, there are also some not-for-profit hospitals paid as public hospitals but run as private ones. They gather only 4.8% of the patients and are excluded from our analysis. Their inclusion does not change the results.

[4] There is a large literature on the use of innovative procedures. It mostly focuses on hospital costs (see Cutler and

Data

We use the exhaustive data on stays in French hospitals provided by the "Programme de Médicalisation des Systèmes d'Information" over the 1998-2003 period. We select patients aged over 35 admitted to a public or a for-profit hospital for an acute myocardial infarction (heart attack). This leaves us with 399,680 patients in 1045 hospitals, with 73.6% of patients staying in public hospitals and 21.6% of them being in for-profit hospitals.

We know the duration of stay and the type of entry: whether patients come from home, or were transferred from another service or hospital. As we do not have any details on the previous stay for transferred patients, we focus on patients coming from home. This makes the sample decrease to 325,760 patients in 1020 hospitals. We also know the type of exit: whether patients die (8%), go back home (59%), or are transferred to another service (2%), another acute care hospital (24%) or another type of hospital (7%). We focus here on exits to death. As we cannot follow patients when they are discharged, all other exits are treated as right-censored.

We have some information on the age and sex of patients, as well as secondary diagnoses and treatment procedures. In particular, we can construct a set of dummies for detailed diagnoses related to the way of life (smoking, alcoholism, obesity, hypertension), chronic health problems (diabetes, conduction diseases, history of coronary disease) and disease complications (renal failure, heart failure).

Among treatments, we can distinguish between bypass surgery which is a traditional procedure, and catheter, angioplasty and stent, which are more recent procedures. All these procedures are meant to deal with the clogged section in a vein or an artery which caused the heart attack. The bypass surgery reroute is a vein or artery collected from the body and set up to derive blood around the blockage. The catheter is a thin pipe installed in a vein to facilitate the injections and drips. The angioplasty consists in inflating a balloon in the catheter to crush a blockage on the side and create a channel. The stent is a spring-shaped prosthesis used as a complement to the angioplasty to keep the artery dilated. This is the most innovative procedure during our period of study and its use has increased over time.

For each hospital, we compute the Kaplan-Meier estimator for exit to death while other types of

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Huckman, 2003) but not on the link between mortality and ownership.

exits are treated as censored. The probability of death is constructed for each hospital as one minus the Kaplan-Meier estimator. It is then averaged by ownership status (public or for-profit), weighting by the number of patients admitted to the hospital. Graph 1 shows the probability of death as a function of the duration (in days) by ownership status. This probability is significantly higher in public hospitals than in for-profit hospitals whatever the duration of stay. For instance, the probability of death after 5 days is 5.8% in public hospitals and only 4.2% in for-profit hospitals as shown in Table A.1 in appendix.

Table 2 presents some descriptive statistics on exits, demographic characteristics, secondary diagnoses and procedures. In particular, for-profit hospitals treat a smaller proportion of patients aged above 80 than public hospitals. They also use more than twice as many stents as public hospitals (40.7% vs. 19.9%). We now propose an approach to assess whether the differences in mortality between public and for-profit hospitals are due to differences in patients' attributes, treatment procedures or intrinsic quality of the hospital.

Empirical strategy

Let i index and $j(i)$ the hospital where patient i is admitted. The discharge can be death, home return, or transfer. We focus on the latent duration before death, the other exits being treated as censored. We consider that this latent duration follows a Cox model stratified by hospital. The hazard rate is given by:

$$\lambda(t|X_i, j(i)) = \lambda_{j(i)}(t)\exp(X_i\beta)$$

where X_i includes the patient's characteristics (age, sex, secondary diagnoses) and the procedures. The vector of coefficients β captures their effect on mortality. $\lambda_j(t)$ is the hazard rate specific to hospital j which is left completely unspecified, allowing for a lot of flexibility in the way hospitals can differ in particular because of their ownership status.

The parameters of the patients' variables are estimated by Stratified Partial Likelihood (Ridder and Tunali, 1999). For every hospital j, an estimator $\hat{\Lambda}_j(t)$ of the integrated hazard $\Lambda_j(t) = \int_0^t \lambda_j(t)dt$ and its covariance matrix can be recovered in a second stage using the estimator proposed by Breslow (1974). The probability of death after a duration t is given by:

$\exp\left(-\hat{\Lambda}_j(t)\right)$, its covariance matrix being recovered using the delta method.

For each duration, we average the probability of death across hospitals by ownership (public or for-profit), weighting the hospitals by the number of patients that they admitted. We will compare the probability of death for public and for-profit hospitals when introducing different sets of patients' variables (individual characteristics and/or treatment procedures). What characterizes our approach is that it allows to compare the probabilities of death between the two types of hospitals across durations.

Results

Table 2 reports the estimated coefficients of patients' variables for three specifications. In column (1), only variables related to age, sex and secondary diagnoses are introduced. As usual in the literature, older people and females are more likely to die. Secondary diagnoses have a negative or positive effect on mortality. A negative effect is a little surprising, but patients with some detected pathologies may be better monitored and thus better treated than other patients. In column (2), we add a dummy for catheter (possibly used jointly with an angioplasty or a stent).[5] They have the expected negative effect on mortality. Finally, in column (3), we replace the dummy for catheter by dummies for detailed procedures (catheter only, angioplasty with catheter, stent with angioplasty and catheter). All the procedures have the expected negative effect on mortality. Note that the estimated coefficient of stent is lower in absolute term than the estimated coefficient of catheter whereas patients treated with a stent also have a catheter and their care is more costly for the hospital. In fact, surgeons treating patients first use a catheter, and then add stents if they consider them necessary because the patients' arteries or veins are too deteriorated. In that case, the estimated coefficient for stent would capture some heterogeneity not observed by the econometrician. This heterogeneity is not observed either by hospitals at admission and should have no effect on the selection of patients by for-profit hospitals.

We now investigate the difference in probability of death between public and for-profit hospitals when controlling for the different subsets of individual variables. Graph 2 represents the

[5] We also added a dummy for by-pass surgery but its introduction is innocuous for the analysis since only 0.9% of patients in our sample are treated with by-pass surgery. We could check that the introduction of this dummy does not affect at all our results.

probability of death as a function of duration by hospital when controlling only for age, sex, and secondary diagnoses in the first stage.[6] The difference in probability of death between public and for-profit hospitals is smaller than the raw difference computed using the Kaplan-Meier estimator (as shown on Graph 1) whatever the duration of stay. For instance, the difference in probability after 5 days is now 0.6% compared to 1.6% on raw data as shown in Table A.1. The difference is even not significant after long durations. Hence, a large part of the difference in probability of death can be attributed to some composition effects. Graph 3 represents the probabilities of death obtained from the model when adding a dummy for catheter (possibly used jointly with an angioplasty or a stent). The difference in probability of death between public and for-profit hospitals is now negative, large in absolute terms and significant after any duration above one day. For instance, the difference in probability of death after 5 days is now -1.2%. This suggests that public hospitals would perform as well or even better than for-profit hospitals, were their disadvantage in means such as catheters and stents corrected. This statement is confirmed by Graph 4 which represents the probabilities of death obtained when replacing the catheter by some dummies for detailed procedures. Indeed, curves remain unchanged.

Conclusion

This paper investigates the mortality gap between public and for-profit hospitals for patients admitted to a French hospital for a heart attack. The more intensive use of innovative procedures by for profit-hospitals contributes largely to explaining this mortality gap. Public hospitals would perform better than for-profit hospitals, were all else equal regarding patients' characteristics and treatment procedures. However, public hospitals are not able to carry out as many innovative procedures as for-profit hospitals because they are financially constrained, which leads them to provide some healthcare of lower quality.

[6]The level of probabilities cannot be directly compared between Graph 1 and Graphs 2-4. Indeed, Graph 1 represents the average probability of death by ownership status. By contrast, Graphs 2-4 represent the probability of death for the reference category of the model by ownership status. Neverheless, it is still meaningful to compare the differences in probability of death between public and for-profit hospitals across graphs.

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Table 1: Descriptive statistics

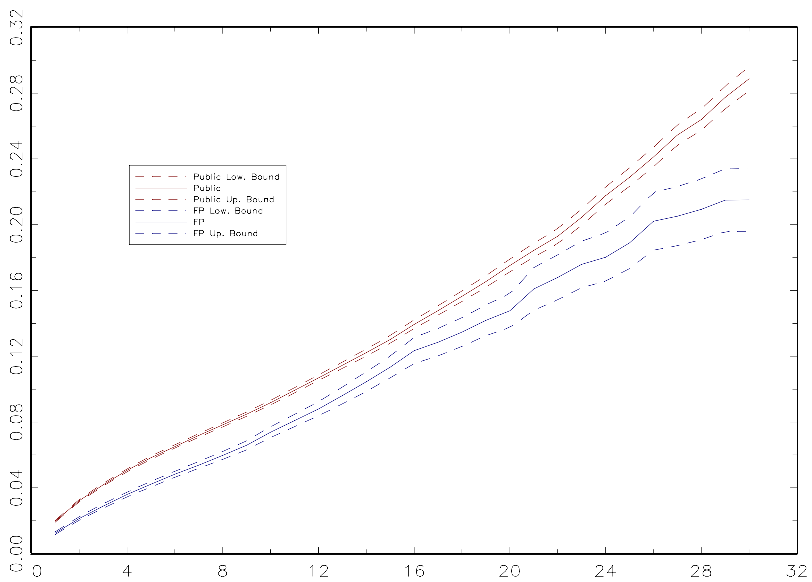
	For-profit	Public	All
Type of exit			
Death	0.060	0.085	0.080
Home	0.699	0.559	0.587
Transfer to another service	0.005	0.023	0.019
Transfer to another acute care hospital	0.149	0.265	0.243
Transfer to another type of hospital	0.087	0.068	0.071
Demographic characteristics			
Female, 35-60 year old	0.035	0.035	0.035
Female, 60-70 year old	0.046	0.044	0.044
Female, 70-80 year old	0.100	0.101	0.101
Female, more than 80 year old	0.102	0.147	0.139
Male, 35-60 year old	0.268	0.253	0.255
Male, 60-70 year old	0.174	0.151	0.156
Male, 70-80 year old	0.189	0.170	0.174
Male, more than 80 year old	0.087	0.099	0.096
Secondary diagnoses			
Alcohol problems	0.011	0.012	0.012
Diabetes	0.169	0.149	0.155
Obesity	0.082	0.057	0.063
Renal failure	0.046	0.050	0.050
Excessive smoking	0.144	0.114	0.120
Hypertension	0.356	0.281	0.299
Surgical French DRGs (GHMC)	0.046	0.034	0.037
Vascular disease	0.068	0.036	0.044
Peripheral arterial disease	0.076	0.058	0.063
Stroke	0.033	0.030	0.032
History of coronary artery disease	0.058	0.035	0.040
Heart failure	0.130	0.163	0.158
Conduction disease	0.203	0.193	0.197
Severity index (IGS)	0.270	0.277	0.283
Treatments			
Cabbage or Coronary Bypass surgery	0.015	0.008	0.009
Catheter (possibly with angioplasty/stent)	0.707	0.432	0.489
Catheter alone	0.239	0.179	0.190
Catheter with angioplasty	0.061	0.055	0.056
Catheter with angioplasty and stent	0.407	0.199	0.245

Table 2: Cox model stratified by hospital,
propensity to die

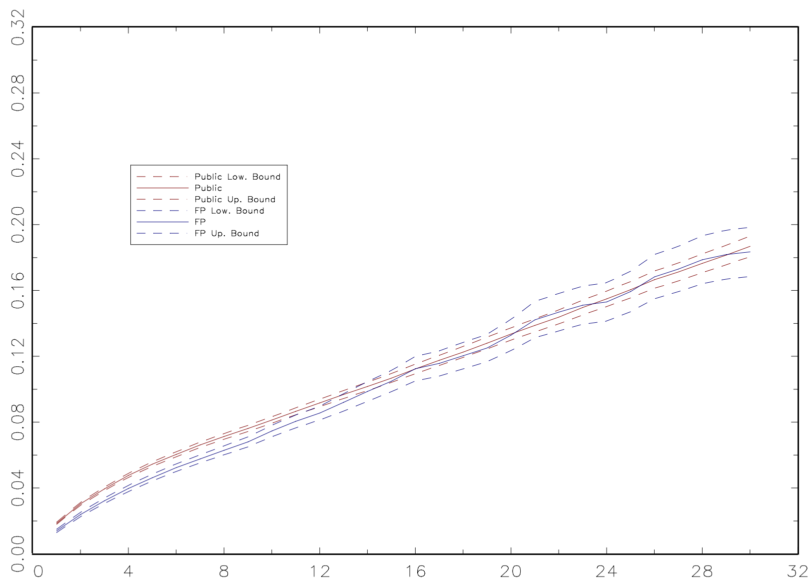
Explanatory variables	Age, sex, diagnoses	Age, sex, diagnoses, catheter	Age, sex, diagnoses, and all procedures
Year 1998	< ref >	< ref >	< ref >
Year 1999	0.160***	0.188***	0.187***
	(0.027)	(0.027)	(0.027)
Year 2000	0.118***	0.167***	0.168***
	(0.027)	(0.027)	(0.027)
Year 2001	0.119***	0.186***	0.187***
	(0.027)	(0.027)	(0.027)
Year 2002	0.077***	0.151***	0.151***
	(0.027)	(0.027)	(0.027)
Year 2003	0.069**	0.142***	0.141***
	(0.028)	(0.028)	(0.028)
Female, 35-60 year old	< ref >	< ref >	< ref >
Female, 60-70 year old	0.661***	0.589***	0.591***
	(0.081)	(0.081)	(0.082)
Female, 70-80 year old	1.196***	1.015***	1.016***
	(0.073)	(0.073)	(0.073)
Female, more than 80 year old	1.863***	1.474***	1.474***
	(0.072)	(0.072)	(0.072)
Male, 35-60 year old	-0.472***	-0.444***	-0.454***
	(0.078)	(0.078)	(0.078)
Male, 60-70 year old	0.375***	0.344***	0.341***
	(0.075)	(0.075)	(0.075)
Male, 70-80 year old	1.010***	0.877***	0.878***
	(0.072)	(0.072)	(0.072)
Male, more than 80 year old	1.675***	1.330***	1.330***
	(0.072)	(0.072)	(0.072)
Alcohol problems	0.447***	0.341***	0.342***
	(0.066)	(0.067)	(0.066)
Diabetes	-0.053***	-0.068***	-0.068***
	(0.018)	(0.018)	(0.018)
Obesity	-0.305***	-0.250***	-0.251***
	(0.042)	(0.042)	(0.042)
Renal failure	0.420***	0.360***	0.360***
	(0.019)	(0.019)	(0.019)
Excessive smoking	-0.570***	-0.492***	-0.496***
	(0.042)	(0.042)	(0.042)
Hypertension	-0.618***	-0.593***	-0.592***
	(0.016)	(0.016)	(0.016)
Surgical French DRGs (GHMC)	-0.019	0.267***	0.247***
	(0.033)	(0.036)	(0.036)
Vascular disease	-0.449***	-0.445***	-0.444***
	(0.030)	(0.030)	(0.030)
Peripheral arterial disease	-0.026	-0.040	-0.036
	(0.025)	(0.025)	(0.025)
Stroke	0.359***	0.296***	0.297***
	(0.025)	(0.025)	(0.025)
History of coronary artery disease	-0.217***	-0.239***	-0.236***
	(0.030)	(0.030)	(0.030)
Heart failure	0.109***	0.063***	0.063***
	(0.014)	(0.014)	(0.014)
Conduction disease	0.889***	0.858***	0.856***
	(0.013)	(0.013)	(0.013)
Severity index (IGS)	0.194***	0.210***	0.208***
	(0.021)	(0.021)	(0.021)
Cabbage or Coronary Bypass surgery		-0.873***	-0.802***
		(0.090)	(0.091)
Catheter		-1.125***	
(possibly with angioplasty/stent)		(0.021)	
Catheter alone			-1.327***
			(0.031)
Catheter with angioplasty			-0.722***
			(0.040)
Catheter with angioplasty and stent			-1.091***
			(0.028)
Number of observations	325,760	325,760	325,760
Number of deaths	25,964	25,964	25,964

Note: ***: significant at 1% level; **: significant at 5% level; *: significant at 10% level.

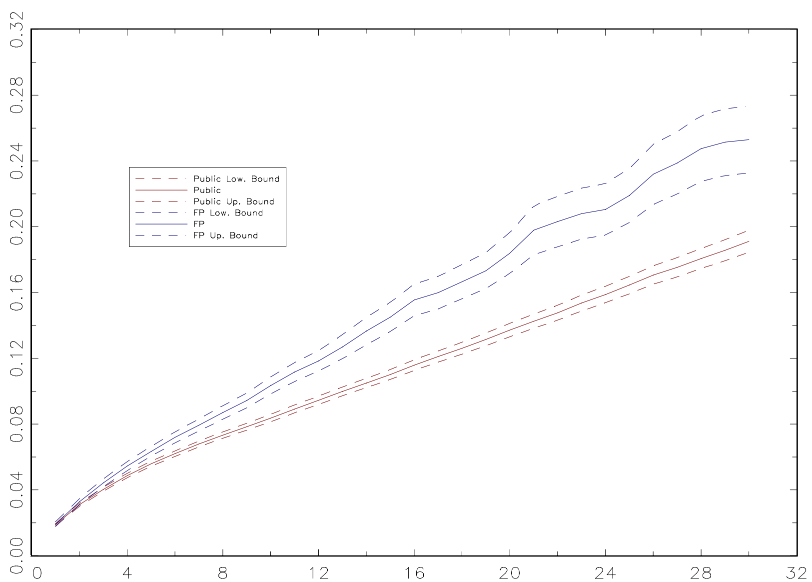
Figure 1: Probability of death as a function of duration (in days)



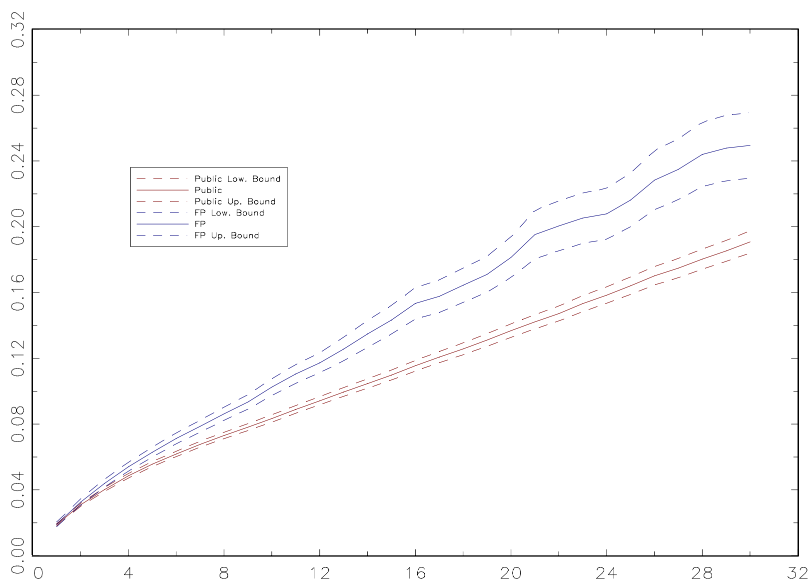
Kaplan-Meier



Model: Age, sex and secondary diagnoses



Model: Age, sex, secondary diagnoses and catheter



Model: Age, sex, secondary diagnoses and procedures

Table A.1: Probability of death by model and hospital status

	Kaplan-Meier		Model : age, sex and diagnoses		Model : age, sex, diagnoses and catheter		Model : age, sex, diagnoses and procedures	
	Public	For-profit	Public	For-profit	Public	For-profit	Public	For-profit
1 day	0.020	0.012	0.019	0.014	0.019	0.019	0.019	0.019
	[0.019,0.020]	[0.012,0.013]	[0.018,0.019]	[0.013,0.015]	[0.018,0.019]	[0.018,0.021]	[0.018,0.019]	[0.018,0.021]
3 days	0.042	0.029	0.039	0.032	0.040	0.044	0.040	0.044
	[0.041,0.043]	[0.028,0.030]	[0.038,0.041]	[0.031,0.034]	[0.039,0.041]	[0.042,0.047]	[0.039,0.041]	[0.042,0.046]
5 days	0.058	0.042	0.054	0.046	0.056	0.063	0.056	0.063
	[0.057,0.059]	[0.041,0.044]	[0.053,0.056]	[0.044,0.048]	[0.054,0.057]	[0.060,0.066]	[0.054,0.057]	[0.060,0.066]
10 days	0.092	0.074	0.081	0.075	0.084	0.103	0.083	0.102
	[0.090,0.093]	[0.071,0.077]	[0.079,0.083]	[0.071,0.078]	[0.081,0.086]	[0.098,0.109]	[0.081,0.086]	[0.097,0.108]
15 days	0.130	0.113	0.107	0.105	0.110	0.145	0.110	0.143
	[0.128,0.132]	[0.107,0.120]	[0.104,0.109]	[0.098,0.111]	[0.107,0.113]	[0.136,0.154]	[0.107,0.113]	[0.135,0.152]

Note: For a given duration, the point estimate is reported on the first row and the confidence interval is reported in brackets on the second row.