Competition in French hospital: Does it impact the patient management in healthcare?

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Abstract

We explore the competition impact on patient management in healthcare (length of stay and technical procedure's probability to be performed) by difference-in-difference, exploiting time variations in the intensity of local competition caused by the French pro-competition reform (2004-2008). Models are estimated with hospital fixed effects to take into account hospital unobserved heterogeneity. We use an exhaustive dataset of in-hospital patients over 35 admitted for a heart attack. We consider the period before the reform from 2001 to 2003 and a period after the reform from 2009 to 2011. Before the reform, there were two types of reimbursement systems. Hospitals from private sector, were paid by fee-for-service. Hospitals from public sector were paid by global budget. They had no current activity's link, and a weak competition incentive. After the DRG-based payment reform, all hospitals compete with each other to attract patients. We find the reform a sizeable positive competition effect on high-technical procedure for the private sector as well as a negative competition effect on the length of stay for public hospitals. However, the overall local competition effect of the reform explained a very marginal part of the explanatory power of the model. Actually, this period is characterised by two contradictory components: a competition effect of the reform and in-patients who are more concentrated. Results suggest that if competition impacted management patient's change, it is through a global competition included in a global trend much more than a local competitive aspect of the reform.

Keywords: competition, hospital ownership, policy evaluation, length of stay, high-tech procedure, difference-in-difference, measure of market structure, heart attack

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I. Introduction

Whereas the healthcare system has long been market-oriented in the US, it was traditionally strongly regulated and more centralized in European countries. However, these countries face the major challenge of keeping health expenditures under control while increasing the quality of their healthcare system. It is widely considered that such a goal can be achieved by giving a greater role to market forces. As a result, a number of countries have implemented healthcare reforms to increase decentralization and favour competition. The Netherlands, Germany, Italy, the United Kingdom and France are some good examples (OECD, 2012).

In this paper, we evaluate the effect on hospital quality of the pro-competition reform, which was gradually introduced in France over the 2004-2008 period. The reform induced competition by imposing a Diagnostic Related Group (DRG) based payment system to both the public and private sectors. As prices are set administratively in France, competition can only occur in quality.

There is a recent and growing empirical literature on the relationship between competition and hospital quality on fixed-price markets which focuses mostly on the US and the UK (for an extensive survey, see Gaynor and Town, 2013). Competition is usually measured with a Herfindhal-Hirschmann index (HHI), which is defined as the sum of squares of all hospital market shares within a given area. Quality of services is commonly approximated with mortality which is not a measure of quality per se, but rather an outcome partially determined by quality. The main reason is that mortality varies with the severity of illness and there is some heterogeneity in this severity across patients.[3] In France, this indicator is so far the only outcome in quality indicator taken by the French Health authorities. Gobillon and Milcent (2018) provided suggestive evidence that patients admitted in non-profit hospitals are less likely to die in less concentrated markets after the reform. For patients admitted in a public or a for-profit hospital, they do not find clear-cut results on the competition effect of the reform on mortality.

In this paper, the channel through which competition effect is assessed is the patient management in healthcare (measured by the spread of high-technical procedure performed and the length of stay changes). The analysis distinguishes hospitals by mission of general interest (status) and hospital's type at granular level

[3] A recent exception is Bynum et al. (2016) who study the effect of hospital competition not only for heart attack but also for hip and knee replacement, and dementia.

Before going further, it is important to underline that in France there is a unique public health insurance system that covers all in-patients, whatever the hospital's ownership. The reform did not impact the patient's out-of-pocket.

A specificity of the French healthcare system is that both sectors provide care of high quality and they both treat a significant share of patients. Before the reform, reimbursement rules differed between the two sectors. The private sector consists of for-profit hospitals, which were paid fees for services. These hospitals already competed with each other for patients attracted to the private sector by a quick adoption of innovative procedures and the good quality of catering and accommodation services. On one hand, the reform may impact the competition process by having intensified competition. On the other hand, as patient's out-of-pocket is not affected by the reform, it is likely that patients' propensity to choose the private sector did not change and for-profit hospitals kept the same healthcare demand. By contrast, hospitals in the public sector were subject to a global budget system before the reform. They include non-profit hospitals, which have a high degree of managerial autonomy, and state-owned hospitals, which have almost no managerial autonomy. Among state-owned hospitals, university establishments receive substantial additional funding for R&D and teaching activities. Besides, before as after the reform, their reputation as high-tech hospitals makes them benefit from a captive demand. As a result, the incentive to attract patients is weakly connected to financial incentives. Turning on Non-Profit hospitals and non-teaching state-owned hospitals, with the reform they are under financial pressure. They differ from each other by the degree of managerial autonomy.

In practice, we first assess the effect of local competition on length of stay. Second, estimate a model for the technical procedures's probability to be performed. We control for hospital fixed effects to take into account hospital unobserved heterogeneity. We use the usual HHI as a measure of market structure, as well as the LOgit Concentration Index (LOCI) introduced by Antwi, Gaynor and Vogt (2013) and used by Colla et al. (2016) in a fixed price setting, and an HHI that takes into account the potential endogeneity of patients' choice of hospital (Kessler and McClellan, 2001). Some studies raised the potential bias to use the AMI patient to compute the HHI and to use the probability of AMI patient's management as dependant variable. To account for this issue, the HHI is computed for elective care. We also compute different HHI based on hip fracture, angina pectoris, AMI.

There is a recent and significant literature on the UK which estimates the effect of competition on quality by exploiting time variations in the intensity of local competition caused by a pro-competition reform introduced over the 2002-2006 period (Cooper et al., 2011; Gaynor et al., 2013). In the same vein, we explore the competition impact on length of stay and on

technical procedure's probability to be performed by exploiting time variations in the intensity of local competition caused by the French pro-competition reform (2004-2008). We consider the period before the reform from 2001 to 2003 and a period after the reform from 2009 to 2011. We then use an exhaustive dataset of in-hospital patients over 35 admitted for an AMI during the 2001-2003 and 2009-2011 periods. A French panel of hospitals over six waves allows us to consider within-hospital patient's management changes.

We find the reform a negative competition effect on the length of stay for public hospitals as well as a sizeable positive competition effect on high-technical procedure for the private sector. This means that the decline in length of stay were larger for public hospitals located in places where there was greater competition than for those in less competitive markets. By contrast, we do not find any significant competition effect of the reform for private sector hospitals. The reform led public hospitals to make adjustments to be competitive. About the increase in high-tech procedure performed in private sector hospital, for-profit hospitals were already competing for funding before the pro-competition reform was introduced. They had the highest rate of high-tech procedures performed before the reform as they have, after the reform. They are their activity positioning on high-tech procedures.

Besides, this period is characterised by two contradictory components: a competition effect of the reform and in-patients who are more concentrated. Actually, the overall competition effect of the reform explained a very marginal part of the explanatory power of the model. Results suggest that there is a global trend in management patient's change that is not explained by the local competitive aspect of the reform.

Our results are robust to the use of our alternative measures of local competition.

The rest of the paper is organized as follows. Section 2 presents the French healthcare system and the pro-competition reform. It also gives some information on our quality indicator and our main measure of local competition. We detail our empirical strategy in Section 4 and comment the results in Section 5. We provide robustness checks in Section 6 and we finally conclude in Section 7.

II. Context

2.1. The French healthcare system and pro-competition reform

In France, the hospital healthcare system is funded publicly. There are three hospital ownership statuses: state-owned, non-profit and for-profit, which characteristics are summarized in Figure 1.

[Insert Figure 1]

We now describe their funding, explain how it was affected by the reform of the hospital healthcare system which took place over the 2004-2008 period, and speculate on the extent to which this reform may have induced competition.

Prior to the reform, hospitals in the public sector (which include both non-profit and state-owned facilities) received a global budget which amount was fixed mainly for historical reasons. They did not have any incentive to attract patients, and they could choose whether or not to work cooperatively, depending on their own will and the influence from local health authorities. In March 2004, the reform called "Tarification à l'activité" — T2A was introduced, and a Diagnostic Related Groups (DRG) based payment system was gradually implemented. The proportion of hospitals under this new reimbursement system was 10% in 2004, 25% in 2005, 35% in 2006, 50% in 2007 and 100% in 2008. Nowadays, all hospitals are paid according to their activity measured by DRGs that take into account the type of pathology, the patient's diagnosis and the degree of pathological severity. A fixed payment is associated to each DRG and the total amount of money received by a hospital depends on the volume of patients with each DRG and the associated fee.[4] As reimbursement depends on the volume of patients, public hospitals now have incentives to compete for patients. As prices are fixed, they can only compete on quality and not on price.

The public sector includes different hospital statuses and we anticipate that the effect of the reform should vary according to the status. Amongst state-owned hospitals, we label as "university hospitals" the facilities to which are assigned teaching and research activities by healthcare authorities. They have high-tech equipment, which is funded even when it is not profitable because of their teaching activities and the public mission of dealing with the patients with the most severe health diagnoses. Besides, they keep receiving additional funding for teaching activities after the reform and this loosens their DRG-based payment constraint. University hospitals also have physicians who are highly trained and qualified. All these features make them attractive facilities for patients before and after the reform. Finally, as state-owned facilities, they have no managerial or financial autonomy, since medical staff and physicians are civil servants. The staffs do not derive any benefit from the accounting profit of their hospital, which must be transferred to the State, and their employment contract has not been modified by the reform. For state-owned hospitals, funding can only be reinvested in the establishment and the accounting profit must be transferred to the State. Gobillon and Milcent (2018) found that

[4] The transition from a global budget system to a DRG-based payment system for hospitals in the public sector shares some features with the reform that was implemented in the UK over the 2002-2006 period.

the incentives for competition induced by the reform to have had a very limited effect on the mortality rate in university hospitals.

We label as "non-teaching public hospitals" the other state-owned facilities. They have fewer beds and admissions, and are characterized by a lower availability and use of high-tech equipment. Overall, they are not the most attractive for patients. Moreover, they have no managerial autonomy before and after the reform. Nevertheless, they receive hardly any additional funding for their public mission compared to university hospitals, and their budget is therefore very sensitive to their activity after the reform. They have to find strategies to attract patients that can be by a change in patient management.

The public sector also includes non-profit hospitals, which are quite unusual compared to those in other countries. Historically, they were related to a religious order or organisation. They were private and more concentrated in the East of France. During the 80s-90s, the central State put pressure on them to integrate the public sector with the objective to increase the healthcare supply in that sector. There were big incentives for non-profit facilities to do so since it provided them with the opportunity of getting subsidized and accessing the pool of patients oriented by doctors to public sector's hospitals. Today, non-profit hospitals are nearly all in the public sector and, since the reform, their budget is entirely determined by their activity. Contrary to state-owned facilities, they have managerial autonomy and their staff is under private labour law. They can thus adjust their labour depending on hospital current and expected activity. [5] The implementation of the reform may thus have triggered a clear-cut and quicker response from non-profit hospitals on patient management, which can make adjustments to be competitive.

In the private sector, hospitals are for-profit and are funded for each stay. Prior to the reform, hospitals received a fee-for-service payment, which amount depended on local health authorities and the procedures implemented during the stay. In March 2005, the fee-for-service reimbursement system was replaced by a DRG-based payment system.[6] Both systems are based on a competitive mechanism, and the main difference is that for-profit hospitals have to face a larger number of competitors after the reform. Indeed, they then do not compete only among themselves, but also with public hospitals and non-profit ones. Ultimately, the competition effect of the reform on the patient management of for-profit hospitals depends on the extent to which the market is locally de-concentrated. It also depends on how public sector is becoming attractive for patient that includes the patient management in care. If the pool of patients usually admitted

[5] Currently, it is the French non-profit hospitals that are the most comparable with the UK public hospitals, not the university and non-teaching public hospitals.
[6] The transition from a fee-for-service system to a DRG-based payment system for private hospitals is similar to the reform that was implemented in the US in the eighties for Medicare patients.

in for-profit hospitals considers that the public sector is not as attractive as the private sector after the reform, the reform is likely to have no effect on for-profit facilities.

We now consider the hospital choice of patients. Individuals can choose rather freely the facility where they receive care, although their tend to be admitted in their region of residence. Over the 1998-2003 period, 93% of AMI patients were treated in their region of residence (Gobillon and Milcent, 2013). There is a unique public health insurance system which covers almost all in-patient expenditures of the whole population, whatever the ownership status of the hospital.

Patients do not have precise information on the patient management of healthcare provided by hospitals even after the reform. Indeed, hospital choice depends mostly on reputation, which is spread by word of mouth from relatives and social networks. A public website managed by a health authority agency provides information on hospitals.[7] However, this website is not popular, the information it delivers is not easy to interpret to get a quick idea of hospital quality in patient management.[8]

2.2. Patient management in healthcare

As high-tech procedures, we consider the treatment with angioplasty. It consists in inflating a balloon in a vein or artery to crush a blockage that caused the heart attack. This procedure cannot be considered strictly as innovative over the period studied here. However, its use was not highly adopted between hospitals over the period studied.

When studying patient management in healthcare, there are some composition effects that should be taken into account with patient characteristics at the individual level. These characteristics include not only age and sex, but also secondary diagnoses and comorbidities. As information on secondary diagnoses and comorbidities is not always available, researchers often use available summary indices such as the Charlson index. In our data, the detailed information on secondary diagnoses and comorbidities allows us to control for them in our regression at the patient level.

2.3. Our indicator for local competition

[7] http://www.scopesante.fr/.

[8] Patients are much better informed about the performances of hospitals in the UK than in France. In the UK, a government-run website gives some details on various aspects of establishment performances including: risk-adjusted mortality rates, hospital activity levels, waiting times and infection rates, all of which are reported by procedure.

A major challenge is to measure local competition with a proper index at the relevant geographic level. This issue is still debated in the literature and alternative proposals have been made by researchers. In this context, we will present results for a specific competition index based on Herfindahl-Hirschman Indices (HHIs) but we also conduct robustness checks presented in Section V.4 using the LOCI index (Colla et al., 2016) and a competition index based on predicted patient flows to deal with the potential endogeneity of patients' choice of hospital (Kessler and Mcclellan, 2000).

Our main measure is an index of local competition centred on the hospital and defined as one minus the average of HHIs computed for every patient taking into account establishments within a 30km radius around her place of residence. More precisely, consider a given patient i and denote by d_{ik} the distance between her place of residence and hospital k. The Herfindahl index for that patient, denoted HHI_i, is given by:

$$HHI_i = \sum_{k|d_{ik}\leq 30km} \left(\frac{N_k}{\bar{N}^i}\right)^2$$

Where N_k is the number of elective care patients in hospital k and $\bar{N}^i = \sum_{k|d_{ik}\leq 30km} N_k$ is the total number of elective care patients within 30km of the patient's place of residence.

The competition measure at the hospital level is obtained by averaging the indexes of all patients within the hospital and it is given by

$$C_j = 1 - HHI^j, \text{ where } HHI^j = \frac{1}{N_j}\sum_{i\in j} HHI_i$$

The larger this measure, the more de-concentrated is the local healthcare market of the hospital. Our index measures hospital competition around the patient. The higher the index, the more competition there is for the patient. When all patients are treated by a single hospital, our competition index takes the value zero, whereas when patients are split equally between n^i hospitals, it takes the value $1 - 1/n^i$. As the number of hospitals tends to infinity, our index converges to one.

As sensitive analysis, we run using addition measurement index of local competition based on hip replacement, angina pectoris and AMI.

III. Empirical strategy

We want to assess whether the reform has led to a change in length of stay and an increase in high-tech procedure's rate due to an increase in local competition between hospitals. For that purpose, we examine whether the effect of our local competition index on length of stay (respectively, high-tech procedure) has evolved towards more negative (respectively, positive) values after the reform. This approach is akin to difference in differences since it amounts to evaluate whether length of stay (respectively, high-tech procedure) has changed (respectively, increased) faster in hospitals located in more competitive markets than in those located in less competitive markets. Identification comes from spatial variations in the competitiveness of local markets following papers studying the UK reform (Cooper et al., 2011; Gaynor et al., 2013). Nevertheless, the French healthcare system is characterized by differences in reimbursement rules before the reform and managerial autonomy across sectors and results for hospitals under different funding regimes can be contrasted.

We estimate the competition effect of the reform on length of stay using a linear model with hospital fixed effects. Consider first that the treatment effect is homogenous. For a patient i in hospital j in yeart t, we have:

$$LOS_{ijt} = \alpha C_{j,t} 1_{\{t>2008\}} + \beta C_{j,t} + \gamma 1_{\{t>2008\}} + X_i\delta + u_j + \varepsilon_i$$

where LOS_{ijt} is the length of stay for a patient *i* admitted to the hospital *j*, year *t*. X_i are patient's characteristics variables, $1_{\{t>2008\}}$ is a dummy variable equal to 1 for years 2009, 2010 and 2011 (equal to zero for years 2001, 2002, 2003,), u_j is a hospital fixed effect and ε_i is the residual. The competition measure at the hospital level is given by

$C_{j,t} = 1 - HHI_{j,t}$ where $HHI_{j,t}$ is a given Herfindahl index.

Now consider that the treatment is heterogeneous such that it depends on hospital characteristics that do not depend on time, Z_j. As characteristics, we use hospital's sector and hospital's type at a granular level . The specification to be estimated becomes:

$$LOS_{ijt} = \alpha C_{j,t} Z_j 1_{\{t>2008\}} + \beta C_{j,t} + \gamma 1_{\{t>2008\}} + X_i\delta + u_j + \varepsilon_i$$

Note that the vector of ones (that corresponds to the constant) is omitted as the specification includes dummies for hospital to avoid identification issues. As well, the Z variables effects are included in hospital dummies.

Assessing the competition effect on the probability of high-tech procedure, we mobilize a similar model where we use a linear model with hospital fixed effects. As robustness check, we also used a Logit model. The pseudo-R^2 is lower than when using a linear model.[9]

IV. Data and Preliminary Statistics

IV.1. Data

We use the exhaustive data on stays in French hospitals provided by the *Programme de Médicalisation des Systèmes d'Information* over the 2001-2011 period, and restrict our attention to patients admitted to a hospital for an AMI without emergency (codes I21 and I22 of the ICD-10-CM codification). In particular, selected patients are able to choose to some extent the hospital where they are treated. Because heart attacks before the age of 35 are usually related to a heart dysfunction, we consider only patients aged 35 and over, which is in line with the OMS definition. We restrict our attention to heart attacks without emergency such that patients are able to choose to some extent the hospital where they can be treated in line with Berta et al. (2016). Stays with duration coded zero (4.6% of observations) are excluded.

We exclude from the analysis patients and hospitals from overseas territories and Corsica, as well as patients from foreign countries, as they are characterized by very specific healthcare. We restrict our sample to patients who come from their place of residence. We thus discard 19.5% of observations.

We have information on the age and sex of patients, as well as detailed information on co-morbidities (i.e. pre-existing conditions), secondary diagnoses and treatment procedures. Detailed co-morbidities and diagnoses are related to the way of life (smoking, alcoholism, obesity, hypertension), chronic health problems (diabetes, conduction diseases, history of coronary disease), disease complications (renal failure, heart failure) and deaths in hospital. We know whether patients were treated or not with a high-tech procedure (an angioplasty).

[9] The results are available upon request

We also have the municipality code of residence and we use it to recover the municipality household median income in 2000 from fiscal data. This measure is used as a proxy for patients' social background that may influence the patient's management.

Finally, our competition index is computed on the whole sample of patients in mainland France. We have the municipality code for both the patients' place of residence and the location of hospitals.[10] We match these codes with an additional dataset containing the coordinates of the town hall and compute the distance between patients and hospitals as crow flies using these coordinates.

We delete 4.12% of observations for which information is missing or miscoded. The resulting sample includes 675,469 stays for mainland France with an average of 51,959 stays per year, with 20.4% of stays being in for-profit hospitals, 3.4% in non-profit hospitals, and 76.2% in public hospital (27.6% in university hospitals and 48.6% in non-teaching hospitals).

IV.2. Preliminary statistics

We first briefly present descriptive statistics over the whole 2001-2011 period by hospital status, which are reported in Table 1. They show that non-teaching public and non-profit hospitals have the largest proportions of male and female patients above 85, old individuals being those who are the most fragile and the most likely to die from a heart attack. There is no clear pattern for secondary diagnoses as, for instance, non-teaching public and non-profit hospitals are characterized by the largest proportions of heart failure and conduction disease, but vascular disease and smoking problems are the most frequent in, respectively, for-profit and university hospitals. The average length of stays is the largest in non-profit and non-teaching hospitals at respectively 7.9 and 7.7 days, and the smallest in for-profit hospitals at 7.0 days, while university hospitals occupy an intermediate position at 7.5 days. The use of high-tech procedures is the most widespread in for-profit and university hospitals where the proportions of patients treated with an angioplasty (possibly with stent) are respectively 61% and 57%, compared to 48% for non-profit hospitals and only 28% for non-teaching hospitals.

[Insert Table 1]

[10] There are around 36,000 municipalities in mainland France. There are two large groups of establishments, one in Paris (called *Assistance Publique – Hôpitaux de Paris*) and the other one in Marseille (called *Assistance Publique – Hôpitaux de Marseille*), for which we do not have a specific municipality code for each establishment. We therefore attribute them the municipality code of the first district in their respective city.

We then turn to stylized facts on the evolution of some quantities of interest over the 2001-2011 period: the competition index, the length of stay and the high-tech procedure's rate. Patients tend to be more concentrated over time since the competition index decreases from 0.51 to 0.44. The length of stay decreased over the period from 6.7 days in 2001 to 7.6 days in 2011. For high-tech procedures, the average of hospital's rate was 35% in 2001 and 55% in 2011. By hospital's type, the increase in high-tech procedure's rate is particularly important for non-teaching public hospitals: from 14% in 2001 to 45% in 2011. For comparison, for research and teaching hospital, it raised from 52% to 65%. The high-tech procedure rate jumped from 37% to 59% in non-profit hospitals. It rose up from 51% to 72% in For-Profit hospitals.

V. Results

In this work, we are interested in evaluating whether the competition effect of the reform has led to a change in patient management and to identify potential differences in hospital sector and at a granular level.

V.1. Length of stay

We first comment the results obtained for patient's casemix on length of stay. Estimated coefficients of individual variables have the expected sign:[11] patients stay shorter when they are males, young, and have no co-morbidities or secondary diagnosis.

We then estimate the model without controlling for the competition effect (Table 2, column (1)). We observe a highly significant global decreasing trend in the length of stay over the period studied.

Table 2, column (2), we consider the overall competition effect. We show that the more competition there is for the patient, the longer the length of stay. The competition within a 30km radius around the place of residence implies a relatively small area. Competitive local areas are places with a high density of population or places where hospitals remained quite small and not yet merged with other(s) hospital(s). Here, we get the effect of decentralized healthcare suppliers over a small territory. We show that for an efficient policy to reduce the length of stay, the regulator has to reduce the number of providers. Over the period, in-patients were more concentrated (see Section IV.2, for stylized facts).

From column (3) to column (5), we show results obtained for the competition effect of the reform. First, we estimate the competition effect of the reform. Table 2, column (3) displays

[11] Estimated coefficients obtained for the full sample are reported in Appendix Table C1.

the overall result: the competition effect of the reform plays negatively and not significantly. This result may mask some heterogeneity in the competition effect of the reform across hospitals. Then, results reported in column (4) show that estimates are quite different when estimating model that controls for sector crossed with competition effect of the reform. For the private sector, the competition effect of the reform is non-significant. By contrast, a negative significant effect at the 1% level is found for hospitals of the public sector. An analysis at a granular level based on the hospital's type is reported in column (5). Results obtained for the competition effect of the reform for public hospitals (teaching hospital and non-teaching ones) show that its estimates are negative significant: In areas where public hospitals competed due to the reform, it led to an decrease effect of length of stay for in-patient admitted to these hospitals. Results are different for private hospitals: Private hospitals are composed of hospitals of the private sector as well as non-profit hospitals that belong in France, to the public sector. The reform is found to have the no local competition effect on length of stay for non-profit hospitals as well as for for-profit hospitals.

This period is characterised by two contradictory components: a competition effect of the reform and patients who tend to be more concentrated (see Section IV.2, for stylized facts). We here have panel data on hospitals, so that we can look at the relationship of hospital length of stay to local competition effect of the reform within the same hospital over time. We here find a effect for the local competition effect of the reform on the decrease of the length of stay, and only for public hospitals.

Overall, whatever the model considered, the trend coefficient over the period is highly significant (at 1% of confidence level). It suggests that there is a global decreasing trend of the length of stay that is not correlated to the local competition effect of the reform. Besides, including the competition effect of the reform does not increase the explanatory power of the model (R^2).

[Insert Table 2]

V.2. High-tech procedures

Results are reported in Table 3. Estimated coefficients of demographic variables have the expected sign: patients have more chance to get high-tech procedure when they are young. For female patients, the probability to get high-tech procedure decreases after 65 year old. For males, it decreases after 75 year old (Milcent et al., 2007). While some secondary diagnoses have a

positive effect on the high-tech procedure's probability, others have a negative effect and this can be explained by risk factors of the corresponding patients (Dormont and Milcent, 2010).

From Table 3, column (1), we find a strong significant increasing trend of the high-tech procedure over the period 2001-2011.

Adding the competition effect to the model (column (2)), we show a positive and significant overall competition effect on the high-tech procedure probability: the more decentralized is the local healthcare market of the hospital, the more likely is the high-tech procedure's performed.

We now propose to assess the average competition impact of the reform on the high-tech procedure's probability (column (3) to column (5)). We used a linear regressions with hospital fixed effects: as such, the effect of local competition effect of the reform on in-patient's high-tech procedure performed is identified solely by seeing how the probability of high-tech procedure's performed within a given hospital changes with the evolution of the local competition due to the reform. We find that the reform has a significant positive average local competition effect when we do not control for hospital's status in the model (column (3)). When we control for hospital's sector (column 4), we observe some similarities in the competition effect. The reform is found to have a positive local competition effect on high-tech procedure performed for private sector. For public sector (public hospital and non-profit ones), we obtain no significant positive effect on high-tech procedure performed probability. Then, controlling for hospital's types (column 5), we find a negative but insignificant effect only for research and teaching public hospitals. The local competition effect of the reform's impact is positive and not significant for the non-profit hospital and for non-teaching hospitals.

In addition, there is overall a strong significant increasing trend effect after the reform that cannot be allocated to sizable change in the local competition effect of the reform.

Besides, we make evidence that the explanatory power of the local competition effect of the reform on the high-tech procedure's performed probability is null. The R-squared is unchanged controlling or not controlling for the competition effect of the reform.

[Insert Table 3]

V.3. Robustness checks

When using alternative competition indices

As alternative competition indices, we consider a maximum scope of 50 kilometres for local competition for a better comparison with our main index. The variable is called HHI_50.

As there is a debate on the right index to use in order to properly capture local competition, we conduct robustness checks using alternative definitions for the competition index. More precisely, the willingness of a hospital to compete for patients may not be related that much to the distribution of patients across local hospitals but rather to the amount of patients located around who are not admitted in the hospital but that could potentially be captured. We thus alternatively use the LOgit Concentration Index (LOCI) introduced by Antwi, Gaynor and Vogt (2013) which is shown to be a relevant measure of local competition in quality for potential patients in a fixed-price setting by Colla et al. (2016). We consider again a maximum scope of 30 kilometres for local competition for a better comparison with our main index. Note that the LOCI varies in the same direction as our competition index since the LOCI increases when competition increases. The correlation between the two indices computed at the patient level over the whole period is 0.42. Results (Table A1 and Table A2) are consistent with our main findings.

Besides, there may be an endogeneity concern when estimating the effect of our benchmark competition index on length of stay and high-tech procedure performed probability. Indeed, this index might be correlated with unobserved patient characteristics not taken into account in our estimations (see for instance Bresnahan, 1989): patients can choose freely among hospitals in France and are likely to select one using the information given by their physician, the press (as a ranking of hospitals is published every year), family and relatives. This would lead to a bias on the estimated coefficient of our competition index. Consistently with the literature, we assess whether the existence of unobservable patient characteristics might bias our estimated coefficients by constructing an alternative competition index from predicted flows of patients to hospitals (see Kessler and McClellan, 2000). We first estimate a logit model of hospital choice, where the explanatory variables are the distance from the patient's municipality of residence to the municipality of the hospital where she is admitted, dummies for hospital statuses and interactions between age bracket and gender dummies. From these estimates, we deduce the probability of each patient going to each hospital, and then compute the predicted number of patients in every hospital. We finally construct a new set of patients' HHI indexes within 30km using predicted numbers of patients in every hospital instead of actual ones. Our alternative competition index for a given hospital is one minus a weighted average of these HHI computed across all patients, where the weight for a given patient is her probability of going to the hospital. The variable is called "Instrumented C Index". It is possible to check that our initial competition index and the predicted competition index are positively related since their correlation is 0.38.

Results obtained, displayed Table A1 and Table A2, when using the predicted competition index are broadly consistent with our initial results.

Estimated coefficients of regressions by hospital's type for length of stay are reported in Appendix, Table A1. Results are consistent with our main findings since the estimated local competition effect of the reform on length of stay is negative and significant for public hospitals (non-teaching hospitals as well as research and teaching hospitals) and not significant for private hospitals (For-Profit hospitals and Non-Profit ones). Nevertheless, the sign of the insignificant impact on non-profit hospitals varies according to the local competition index considered. Besides, at a scope of 50 kilometres for local competition, the positive local competition effect of the reform on length of stay for research and teaching hospitals is insignificant.

Results reported in Table A2 displays estimates for high-tech procedure's probability. As previously, we find that the reform has a significant and positive effect on the For-profit hospitals. Results are slightly different for research and teaching hospitals when using competitive index at a scope of 50 kilometres, since the local competition effect of the reform on high-tech procedure after the transition period is now negative and significant. We also observe that for local competition, the overall local competition effect is not significant.

Robustness checks when using alternative care for measurement index of local competition

We also assess to what extent the care is important to measure the index of local competition. In this paper, we consider the elective care stays to set up the measurement index of local competition. We now compare our main estimates of the competition effect of the reform with those obtained with measurement index of local competition based on hip replacement, angina pectoris and AMI.

In Appendix, Table A1 shows that, results for the length of stay obtained when using the predicted competition index are broadly consistent with our initial results.

When turning to the estimations for the high-tech procedure performed, we get similar results for non-profit, non-teaching and for-profit hospitals when using our initial and alternative competition indexes.

VI. Conclusion

Health expenditures are growing in most countries and governments are looking for ways to control spending while improving health care. There is a growing interest in competition among hospitals as it may improve quality in fixed-price markets. We, here, explore the effect on the patient management in care.

So far, studies have mainly focused only on the competition effects in a single sector. In France, the healthcare market was and is still composed of public and private hospitals. The reform gradually introduced in France over the 2004-2008 period did not introduce any change in the structure of this market. In this paper, we study the effect on hospital patient management of this pro-competition reform by hospital status. For each hospital status, we assess the effect of the reform using a difference-in-differences approach which consists in quantifying to what extent length of stay (respectively, technical procedure's probability to be performed) for heart-attack patients changed more in more competitive markets than in less competitive markets after the reform. We assess whether hospital patient's management in more competitive markets increased more after the reform than that in less competitive markets, respectively for for-profit, public (university or non-teaching) and non-profit hospitals. For that purpose, we estimate a linear model for length of stay and for high-tech procedure performed on an exhaustive dataset of heart attack patients admitted in a hospital during the 2001-2011 period.

We here show that this relationship between public-hospital length of stay and the competition effect of the policy holds using within-hospital variation. This means that the decline in length of stay was larger for public hospitals located in places where there is greater competition than for those in less competitive markets. These results show that both the initial funding system and management matter to obtain a positive competition effect of the reform on hospital patient's management.

We find that for-profit hospitals performed more intensively high-tech procedures in places where there is greater competition than in less competitive markets. It may be explained by a high-tech positioning act of the private sector hospital that is more profitable.

Ours results are robust to taking into account the endogeneity of patient hospital choice when constructing our competition index as well as alternative radius around her place of residence, or the amount of patients located around who are not admitted in the hospital but that could potentially be captured (LOCI). Our results are also robust when using alternative care for measurement index of local competition.

However, the overall local competition effect of the reform explained a very marginal part of the explanatory power of the model. Actually, this period is characterised by two

contradictory components: a competition effect of the reform and in-patients who are more concentrated. Results suggest that if competition impacted management patient's change, it is through a global competition included in a global trend much more than a local competitive aspect of the reform.

The literature suggests that one channel through which local competition may affect hospital quality is a change in patient's management quality including adjustments in technological equipment and length of stay, but other mechanisms are worth exploring. There are dimensions of hospital quality other than length of stay and high-tech procedure that could be investigated such as waiting time, comfort, attention paid by the staff and more generally the well-being of patients. These questions are left for future research.

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Table 1. Summary Statistics by Hospital Status (2001-2011)

Variable	All hospitals		University hospitals		Non-teaching public hospitals		Non-Profit Hospitals		For-Profit hospitals	
	Mean (%)	Std	Mean (%)	Std	Mean (%)	Std	Mean (%)	Std	Mean (%)	Std
Female, 55-65	3.15	0.17	3.35	0.19	2.90	0.17	2.87	0.17	3.18	0.18
Female, 65-75	6.24	0.24	6.02	0.24	6.24	0.24	6.17	0.24	6.34	0.24
Female, 75-85	11.43	0.32	9.62	0.29	12.75	0.34	12.63	0.33	10.84	0.31
Female, more than 85	8.48	0.28	6.19	0.24	11.00	0.31	11.34	0.32	5.80	0.23
Male,35-55	18.05	0.39	21.57	0.41	16.03	0.37	15.81	0.38	18.00	0.38
Male,55-65	15.13	0.36	17.37	0.38	13.37	0.35	14.53	0.35	16.86	0.37
Male,65-75	15.31	0.36	15.57	0.36	14.38	0.35	14.51	0.35	17.04	0.38
Male,75-85	14.00	0.35	12.58	0.33	14.60	0.35	13.70	0.34	14.93	0.36
Male, more than 85	4.87	0.22	3.73	0.19	5.87	0.24	5.66	0.23	4.18	0.20
Alcohol problem	1.43	0.13	1.56	0.13	1.56	0.13	1.13	0.11	1.03	0.10
Smoking problem	14.55	0.36	18.78	0.40	13.14	0.34	9.57	0.30	13.03	0.34
Obesity	8.70	0.29	11.01	0.33	7.34	0.26	8.01	0.27	8.71	0.28
Diabetes	18.95	0.43	18.90	0.45	19.02	0.42	19.58	0.42	18.76	0.40
Hypertension	36.85	0.49	36.56	0.49	35.94	0.49	38.04	0.49	38.92	0.49
Renal failure	7.44	0.28	7.97	0.30	7.78	0.29	8.53	0.29	5.59	0.24
Vascular disease	6.09	0.26	4.75	0.24	5.68	0.25	6.64	0.26	8.55	0.30
Peripheral arterial disease	6.64	0.27	6.79	0.28	6.05	0.25	9.37	0.33	7.28	0.28
Other vascular disease	3.33	0.19	3.13	0.19	3.41	0.19	3.38	0.19	3.37	0.19
Other ischemic disease	5.10	0.23	3.83	0.20	4.30	0.21	5.42	0.23	8.26	0.29
Heart failure	16.30	0.38	14.10	0.36	19.14	0.40	19.82	0.41	14.44	0.35
Conduction disease	21.02	0.41	17.86	0.38	18.24	0.40	23.30	0.42	21.64	0.41
High-tech procedure	44.47	0.50	58.71	0.49	27.46	0.45	43.68	0.50	61.64	0.49
Length Of Stay	7.13	7.06	7.07	7.95	7.43	6.90	7.48	7.25	6.53	5.99

Note. Std: Standard Deviation. Descriptive statistics computed on the sample of patients aged 35-100 admitted from their place of residence (and not a transfer).

Table 2. Competition effect of the reform on length of stay between 2001 and 2011, Linear fixed effect models

	Dependent variable : Length of stay				
Variables	-1	-2	-3	-4	-5
Reform dummy ($1_{\{t>2008\}}$)	-1.355***	-1.297***	-1.187***	-1.018***	-1.016***
	(0.0188)	(0.0237)	(0.0948)	(0.0961)	(0.0971)
Competition ($C_{j,t}$)		0.223***	0.234***	0.263***	0.268***
		(0.00504)	(0.00506)	(0.00358)	(0.0846)
Reform*competition			-0.149		
			(0.125)		
Private sector: Reform*competition				0.152	0.151
				(0.128)	(0.129)
Public sector Reform*competition				-0.341***	
				(0.078)	
Non-profit hospitals					-0.227
					(0.176)
Research and Teaching hospitals					-0.662***
					(0.133)
Non-teaching public hospitals					-0.368***
					(0.142)
Hospital fixed effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
R-squared	0.200	0.203	0.203	0.203	0.203

Note. *significant at 10% level; ** significant at 5% level; *** significant at 1% level. Standard errors are reported in parentheses. C=1-HHI where HHI is the hospital weighted average of Herfindahl-Hirschman indexes computed for every patient taking into account establishments within a 30km radius around her place of residence. All specifications include as control variables individual characteristics related to case-mix (interactions between sex and age brackets, detailed information on secondary diagnoses and comorbidities, average income in the municipality) and procedure (treatment with angioplasty). We do not include any private sector dummy because its coefficient is not identified since the linear model is controlled for hospital fixed effects.
The whole set of estimates available upon request.

Table 3. Competition effect of the reform on high-tech procedure probability between 2001 and 2011, Linear fixed effect models

	Dependent variable : High-tech innovative procedure				
Variables	-1	-2	-3	-4	-5
Reform dummy ($1_{\{t>2008\}}$)	0.173***	0.179***	0.222***	0.213***	0.210***
	(0.00152)	(0.00192)	(0.00766)	(0.00776)	(0.00784)
Competition ($C_{j,t}$)		0.0859***	0.0762***	0.0671**	0.0546***
		(0.0274)	(0.0274)	(0.0274)	(0.00766)
Reform*competition			0.0181***		
			(0.00168)		
Private sector: Reform*competition				0.0275***	0.0227***
				(0.00444)	(0.00452)
Public sector Reform*competition				0.00374	
				(0.0105)	
Non-profit hospitals					0.00697
					(0.00578)
Research and Teaching hospitals					-0.00719
					(0.0115)
Non-teaching public hospitals					0.00493
					(0.0107)
Hospital fixed effect	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
R-squared	0.200	0.203	0.203	0.203	0.203

Note. *significant at 10% level; ** significant at 5% level; *** significant at 1% level. Standard errors are reported in parentheses. C=1-HHI where HHI is the hospital weighted average of Herfindahl-Hirschman indexes computed for every patient taking into account establishments within a 30km radius around her place of residence. All specifications include as control variables individual characteristics related to case-mix (interactions between sex and age brackets, detailed information on secondary diagnoses and comorbidities, average income in the municipality) and procedure (treatment with angioplasty). We do not include any private sector dummy because its coefficient is not identified since the linear model is controlled for hospital fixed effects.
The whole set of estimates available upon request.

Table A1. Competition effect of the reform: Alternative definitions of local competition indices on length of stay

Dependent variable: length of stay

	Alternative competition indices			Pathology or procedure chosen to compute the HHI		
	HHI_50	LOCI	Instrumented C Index	AMI	hip	Angina pectoris
Variables	-1	-2	-3	-4	-5	-6
Reform dummy ($1_{\{t>2008\}}$)	-1.228**	-1.442***	-1.220***	-1.194***	-1.192***	-0.869***
	(0.0412)	(0.117)	(0.0375)	(0.0358)	(0.0377)	(0.168)
Competition ($C_{j,t}$)	0.0283***	0.0281*	0.265***	0.289***	0.354**	0.240***
	(0.00493)	(0.0150)	(0.0192)	(0.0872)	(0.142)	(0.139)
Private sector: Reform*competition						
For-Profit hospitals	0.0298	0.445	0.0525	0.0323	0.0458	0.0614
	(0.0293)	(1.072)	(0.118)	(0.0267)	(0.0892)	(1.083)
Public sector : Reform*competition						
Non-profit hospitals	0.0520	-0.00714	-0.0354	0.0960	0.00863	0.0847
	(0.157)	(0.00875)	(0.248)	(0.0689)	(0.0145)	(1.077)
Non-teaching public hospitals	-0.0174	-0.0687***	-0.108***	-0.0293***	-0.0548***	-0.0728***
	(0.0109)	(0.00818)	(0.00958)	(0.0107)	(0.00195)	(0.00646)
Research and Teaching	-0.177***	-0.118***	-0.0580*	-0.0343***	-0.0832**	-0.106***
hospitals	(0.0274)	(0.00900)	(0.0107)	(0.00835)	(0.0411)	(0.0361)
Hospital fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.383	0.390	0.327	0.387	0.390	0.388

Note. * significant at 10% level; ** significant at 5% level; *** significant at 1% level. Standard errors are reported in parentheses. C=1-HHI where HHI is the hospital weighted average of Herfindahl-Hirschman indexes computed for alternative competition indices: HHI_50: Every patient takes into account establishments within a 50km radius around her place of residence. LOCI Index: LOgit Competition Index; Instrumented C Index: one minus instrumented HHI where instrumented HHI was constructed using Kessler and McClellan (2000)'s procedure.
We also compute different HHI based on hip fracture, angina pectoris, AMI.
All specifications include as control variables individual characteristics related to case-mix (interactions between sex and age brackets, detailed information on secondary diagnoses and comorbidities average income in the municipality). We do not include any hospital's statuses dummy because its coefficient is not identified since the linear model is a fixed hospital effect linear model.
The whole set of estimates available upon request.

Table A2. Competition effect of the reform on high-tech procedure probability between 2001 and 2011, Linear fixed effect models

Dependent variable: high-tech procedure performed

	Alternative competition indices			Pathology or procedure chosen to compute the HHI			
	HHI_50	LOCI	Instrumented C Index	AMI	hip	Angina pectoris	
Variables	-1	-2	-3	-4	-5	-7	
Reform dummy ($1_{\{t>2008\}}$)	0.345***	0.941 ***	0.780**	0.296***	0.234***	0.150***	
	(0.0216)	(0.00665)	(0.357)	(0.0514)	(0.00506)	(0.0249)	
Competition ($C_{j,t}$)	0.0941	0. 308***	0.292***	0.162***	0.289***	0.108***	
	(0.0989)	(0.0817)	(0.0249)	(0.00868)	(0.0179)	(0.0107)	
Private sector: Reform*competition							
For-Profit hospitals	0.0774***	0.123***	0.0831**	0.107***	0.0642***	0.0298***	
	(0.0230)	(0.00820)	(0.0353)	(0.00691)	(0.00795)	(0.0150)	
Public sector : Reform*competition							
Non-profit	0.0897	0.0136	0.0271	0.0371	0.151	0.154	
hospitals	(0.0944)	(0.0622)	(0.0182)	(0.0718)	(0.129)	(0.160)	
Research and Teaching	-0.0683***	-0.0614	-0.0233	-0.0147	-0.0101	-0.0229	
hospitals	(0.0240)	(0.251)	(0.141)	(0.0703)	(0.0560)	(0.0902)	
Non-teaching public	0.0765	0.0491	0.00843	0.0210	0.0662	0.0908	
hospitals	(0.1234)	(0.506)	(0. 0178)	(0.0141)	(0.133)	(0.204)	
Hospital fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	
R-squared	0.383	0.390	0.327	0.387	0.390	0.329	0.388

Note. * significant at 10% level; ** significant at 5% level; *** significant at 1% level. Standard errors are reported in parentheses. C=1-HHI where HHI is the hospital weighted average of Herfindahl-Hirschman indexes computed for alternative competition indices: HHI_50: Every patient takes into account establishments within a 50km radius around her place of residence. LOCI Index: LOgit Competition Index; Instrumented C Index: one minus instrumented HHI where instrumented HHI was constructed using Kessler and McClellan (2000)'s procedure.
We also compute different HHI based on hip fracture, angina pectoris, AMI.
All specifications include as control variables individual characteristics related to case-mix (interactions between sex and age brackets, detailed information on secondary diagnoses and comorbidities average income in the municipality). We do not include any hospital's statuses dummy because its coefficient is not identified since the linear model is a fixed hospital effect linear model.
The whole set of estimates available upon request.

Figure 1. Description of hospital ownership statuses in France

Type	University hospital	Non-teaching public hospitals	Non-profit hospitals	For-profit hospitals	
Public status	Yes		No		
Public sector	Yes			No	
Ownership	State-Owned		Non-Profit	For-Profit	
Workers' status for non-doctors	Civil servants and salaried workers		Salaried workers		
Workers' status for doctors	Civil servants		Salaried workers and private practice		
Profit	No profit Surplus given to the state		Cannot make profit but surplus can be re-invested	Can make profit	
Before reform					
Funding	Global budget			Fee-for-service	Per diem
Medical devices	No additional budget			Reimbursed per unit, tariff defined at the local level	
Research activities	Additional budget[12]	No	No	No	
After reform					
Funding	DRG-based payment				
Medical devices	• When on a restricted list, reimbursed per unit, tariff determined at the national level • When not on the list, no additional payment				
Research activities	Additional budget[22]	No	No	No	

[12] Part of the additional budget for research activities may have been used for medical devices such as stents for AMI patients.

Appendix A. Details on the Logit Concentration index

We explain in more details here how the Logit Concentration Index (LOCI) is constructed following Antwi, Gaynor and Vogt (2013) and Colla et al. (2016). The LOCI index for a given hospital captures the fractions of patients in municipalities which are not admitted in that hospital. It therefore corresponds to the potential market of the hospital. The LOCI is given by the formula:

$$\Lambda_j = \sum\nolimits_{m \in \Phi_j} \frac{N_m S_{m \to j}}{\sum_{m \in \Phi_j} N_m S_{m \to j}} \left(1 - S_{m \to j}\right)$$

where m indexes the municipality, Φ_j is the set of municipalities from which the hospital draws patients, $S_{m \to j}$ is the share of patients in municipality m admitted in hospital j and N_m is the number of patients in municipality m.

The LOCI takes the value zero when the hospital has admitted every patient living in municipalities from which it draws patients. The LOCI tends to one when the market is perfectly competitive and $S_{m \to j}$ tends to zero for all municipalities. It is important to note that the HHI and LOCI differ in their treatment of large and small hospitals. Consider a geographic area consisting in two municipalities such that there is a large hospital in a municipality and a small one in the other municipality. Suppose that each hospital draws the same proportional number of patients from each municipality. The HHI is identical for the two municipalities and so is then the HHI of the two hospitals, as a hospital HHI is computed as the weighted average of municipality HHIs (where the weight is the hospital share of patients coming from the municipality). By contrast, the LOCI is higher for the small hospital because the fraction of patients in each municipality not admitted in that hospital is larger. This index better captures the idea that there would be a larger potential market for the small hospital and thus more incentives for competition.