

# Hospital Staffing, Skill Mix and Local Pay: an Investigation into the Impact of Local variations in the Competitiveness of Nursing-Pay on the Staffing of Hospitals in France

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## Abstract

Research for England has shown that differences in the pay setting arrangements for nurses and their private sector comparators produce spatial variations in the competitiveness of nurses pay. Further it has shown that variations in competitiveness are associated with differences in nursing vacancy rates. This paper explores whether similar variations in the spatial competitiveness of nurses pay exist in France and whether any variations in competitiveness are associated with variations in hospital staffing levels and skill mix. In France private for profit and not for profit hospital operate alongside public hospitals and thus compete directly for staff. In France collective bargaining plays a prominent role in determining pay structures in both the public and private sectors and thus we might expect fewer differences in the spatial patterns of pay between these two sectors in France. For both these reasons it is interesting to study the relationship between wage setting, local labour market conditions and hospital staffing in France. The empirical results show that the local competitiveness of nurses pay affects both staffing levels and skill-mix in public sector hospitals in France. However the results are mixed and do not apply to all groups and refinement of method and estimation is required.

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# 1. Introduction

Nurses unions in France have complained that there are not enough nurses in hospitals (Depoire 2011). Com-Ruelle et al. (2000) reveal the problem is more general and there are shortages of nurses in several European countries. An OECD report published in 2005 (Simoens et al. 2005) confirmed an international shortage of nurses and de Pourvoirville (2002) argues that it exists also for France. Yet according to Baret (2002) there is no measure of the shortage in France. The only quantitative evidence for a shortage in nurses in France is a shortfall in recruitment of students in nursing education. A report from the National Observatory on the demography of health professions (Observatoire national de la démographie des professions de santé (ONDPS) 2006) highlights the shortage of nurses in education relatively to the number of places funded<sup>1</sup>. Moreover it shows widespread regional variations in these shortages suggesting that local conditions play a part in accounting for these shortages. Thus while 1% of places in nurse training were not filled in 2004 in Aquitaine, the shortage amounted to 22% in Ile de France. In 1999, the government increased by 43% the number of places available in nursing education (Com-Ruelle et al. 2000) which was an implicit recognition by the government that there was a shortage. Though there is much discussion about the national shortage of nurses there is none about local variations in nurse shortages (Salvage & Heijnen 1997) and certainly no empirical evidence on the nature or explanation for these.

The aim of this paper is two fold: first to investigate the impact of spatial variations in the competitiveness of nurses pay on spatial variations in nursing staff levels in French hospitals and; second to analyse the impact of spatial variations in the competitiveness of nurses pay on skill mix in French hospitals.

## 1.1. Wage differentials

This paper positions itself in the literature analysing the impact of pay in the public sector, with a more specific focus on nurses recruitment and retention (Bell et al. 2007; R. F. Elliott et al. 2007; Propper & Van Reenen 2010). Elliott et al. (2007) found that differences in the pay setting arrangements for nurses and their private sector comparators in England resulted in differences in the spatial pattern of pay for the two groups. In England nurses pay is established through an institutional process which reduces the effect of local market conditions on nurses pay. In contrast the pay of their comparators is the result of market forces operating in local labour markets where collective bargaining plays a minor role in setting pay. This results in spatial differences, spatial 'gaps', between nurses pay and that of their comparators and these were found to be associated with nursing vacancy rates in hospitals in England (R. F. Elliott et al. 2007). Propper & Van Renen (2010) revealed the consequence of these shortages for they showed that the gaps between nurses pay and pay in the private sector was associated with higher levels of death rates due to Acute Myocardial Infraction in English hospitals.

This paper builds on this literature to investigate whether any similar gaps in pay between nurses in public hospitals and nurses in private sector hospitals as well as employees in the private sector more generally exist in France and if they do whether they are associated with local variations in staffing levels in hospitals in France. In France, hospitals fall into three legal entities: hospitals in the public sector, private not for profit hospitals and private for profit hospitals. France therefore represents a particularly interesting context in which to explore this issue for in France private sector hospitals are direct competitors for the nursing staff employed in public hospitals.

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1 In France training places for nurses are funded by the ministry of education.

The effect of recruitment by hospitals in the private sector on recruitment of nurses to the public sector in England is by contrast very small. Finally we shall explore whether hospitals in France try to dampen any adverse effects of nurse shortages by changing the staff-mix.

The theory of compensating wage differentials provides a theoretical framework to explain why the 'underlying' structure of pay differs between geographical areas (Smith 1776; Rosen 1986). Higher pay in some areas of the country is expected where the cost of living is higher while higher pay is also necessary to compensate for a less pleasant working environment. Empirical research on the topic is not clear cut. Researchers found that wage differentials, on average, reflect job and individual characteristics (Reilly 1992; García & Molina 2002; Pereira & Galego 2011) but that regional wage differentials only partially reflect differences in amenities and cost of living (Vermeulen & Van Ommeren 2009; Blackaby & Murphy 1991; Blackaby & Murphy 1995; Shah & Walker 1983). Some wage differentials remain and in some circumstances were reversed by introducing cost of living (Blackaby & Murphy 1995). Combes et al. (2008) explore causality and suggest that differences in wages between regions may be endogenous; workers with higher skills and more productive labour market characteristics may agglomerate in denser, less attractive, and more highly skilled, and paid, regions.

Exploring this latter dimension is beyond the scope of this paper. Here we build on the research of Elliott et al. (2007) and Propper & Van Reenen (2010) to explore the impact of local competition on hospital staffing and skill mix in France.

### *1.2. Wage differentials and outside wages*

In France pay is set through collective bargaining with 95% of employees covered by collective bargaining arrangements in 2000 (Traxler & Brandl 2011). The impact of unions and collective bargaining in the pay structure is widely studied by economists and the research reveal that collective agreements are less likely to let pay vary locally (Rosen 1986; Traxler & Brandl 2011; Hayter & Weinberg 2011; Card et al. 2003; Bassanini & Duval 2006; Blackaby & Murphy 1991; Metcalf et al. 2001). Reviewing the link between unions and wage dispersion Hayter & Weinberg (2011) argue that there is an extended body of literature that confirms that unions tend to compress wage structure. The wage structure is compressed within the unionised sector but also wage dispersion is less between the union and non union sectors when collective bargaining is more widespread. Overall unions decrease wage dispersion. The authors emphasize that these results stand the test of time and that more sophisticated econometric analysis confirms that overall unions reduce wage inequality (Card et al. 2003).

Despite the coverage of collective bargaining in France pay dispersion between French regions and sectors may still occur (Meurs & Edon 2007). Collective bargaining is conducted at several different levels in France. Branch agreements, negotiated nationally have to be respected by all firms within a branch even those not participating in the bargain (Meurs & Edon, 2007). However firm agreements can also add a layer which cannot be less favourable to the employee than the branch agreement or even the law and this may be a source of greater wage dispersion.

In the public sector local agreements are not possible. If there is no agreement between unions and the employer (the government), the government will award across the board pay increases unilaterally, there has not been any agreement since 1998 (Meurs & Edon, 2007). Public sector hospitals in the least attractive regions are not able to offer higher rates of pay to attract employees to work in these areas (Meurs & Edon, 2007). However, grade drift is possible and could act to reduce shortage. Drift may occur in both the public and private sectors though it is not clear whether it is easier in one sector than the other to employ this mechanism to increase pay. Meurs & Edon (2007) found, using the Labour Force Survey of 2002 for France, that in the private sector

(including private for profit hospitals) pay dispersion was greater than in the public sector (all public sector, excluding publicly owned companies) and that the degree of variation (when controlling for individual and firm characteristics) differed across the country. It appears that collective bargaining in France does not result in a totally flat pay structure across the country and spatial variations in the competitiveness of nurses pay, in the gap between the pay of nurses in the public and private sectors may exist.

### *1.3. Scope of the analysis*

It is hypothesized that spatial differences in the competitiveness of nurses pay, differences in the spatial patterns of pay in the public and private sectors of the French economy may result in wage gaps between nurses working in hospitals in different sectors and between nurses and employees in other sectors of the economy. We will test to see whether these gaps vary geographically. This paper will analyse the impact of any wage gaps between the pay of nurses working in hospitals in the public and private sectors and the impact of any wage gaps between the pay of nurses working in public hospitals and employees in other sectors of the economy on nurse staffing levels and hospital nursing staff mix.

There are several different measures of staff shortage. Grumbach et al. (2001) propose different measure of shortage in hospitals, staff level, vacancy rates, turn over and reported levels of staff shortages. Grumbach et al. (2001) correlate vacancy, turn over and staff levels with reported shortages by managers for US hospitals<sup>2</sup> and find that there are weak correlations which according to the authors are interpreted as each measure showing different aspects of nurse shortage. They further argue that there is no perfect definition of what constitutes shortages. The level of staff defined as the number of staff (eg nurses) per inpatients day could be seen as a better measure of shortage than the others because it would reflect the labour supply standardised for actual patient need but this would not be correct as some procedures and therefore some patients may require more staff than others. Similar, but different criticisms could be made of the other measure of shortages. Vacancy rates, for example, may underestimate shortages as hospitals may use alternative ways of resolving their shortages. It would seem to follow that each of these different measures should be used to assess more efficiently the nature of any shortages.

There are no detailed statistics on nursing vacancies, and nursing turn-over by geographical area in France, only staff numbers are available and we shall use these.

Nursing staff numbers will be standardised by size of hospital, because larger hospitals would be expected to employ more nurses. Some hospitals may undertake activities which are more labour intensive than others and therefore require higher staff levels. Analysing the impact of wage gaps on staffing levels will not be meaningful unless controls for hospital activity are introduced. Where these controls standardise for the determinants of hospital staffing levels then the impact of staff levels of any other variables that are included in the estimation will capture further drivers of hospital activity levels.

For the UK, Elliott et. al. (2006) measured nursing shortages by the nursing vacancy rates of hospitals. They found that a larger gap between private and nurses pay resulted in higher nursing vacancy rates in public hospitals. Hospitals may try alternative solutions in order to reduce the scope of shortages and its impact on service delivery. One of these could be to alter the staff mix of their healthcare team. Thus in theory any shortage of staff, due to local labour market conditions, could be resolved or at least reduced as a result of the adaptive behaviour of the hospitals.

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2 They used data from the Annual Survey of Hospitals carried out by the American Hospital Associations, and Nursing Personnel Survey from 1990 and 1992.

The impact of wage gaps on both staff levels and staff-mix in French public hospitals will be investigated in this paper.

The paper is in six sections. Section 2 describes the French hospital system, while section 3 describes the data available for France which is used in this analysis. Sections 4 and 5 will present the models that will be tested and their results, the final section (6) will conclude and discuss the results.

## 2. French health-care setting

### 2.1. Status of hospitals

Hospitals in France are divided into three different legal types: public hospitals, private not for profit hospitals and private for profit hospitals. Public hospitals<sup>3</sup> can be large regional hospitals providing education, research, acute care, and advanced treatments, or local hospitals which run a smaller acute or maternity ward. Local hospitals depend on large regional hospitals for most of the technical care. They also rely on ambulatory care medical doctors to provide some of their services. All public hospitals run an emergency service.

Not for profit hospitals are associations, mutual establishments, foundations, in which any surplus over costs is reinvested into the services provided for patients (it could be invested in new technologies for example). For profit hospitals have a commercial status and aim to make profit. Usually of smaller size, no private hospital will be as large as regional public hospitals. Private for profit hospitals tend to specialise in routine procedures. Some private not for profit hospitals participate in the public service, and therefore have to fulfil similar goals to public hospitals (see the following section). They do not engage in education and research which is confined to large regional public hospitals. Both public and private hospitals are regulated by the same body. Regulation covers both financial and non financial matters.

### 2.2. Public service

Public service health-care in France (at the hospital level) is provided by public hospitals and private ones which decide to participate in the public service (“service public hospitalier”) (Code de la Santé Publique 1993). Private hospitals, whether for profit or not for profit, can participate in the public hospital service. The advantage to private hospitals of participating in the the public service is that they get subsidies for equipment. In exchange they have to provide a similar service to public hospitals: they have to be able to make their premises available at any time of the day and night and run an emergency ward or be able to redirect patients to a hospital that runs one (equal access to all; continuous access even for potentials emergencies; continuity of care; patients are reoriented if necessary and given everything to continue the care needed once they left the hospital)<sup>4</sup>. Private hospitals not participating in the public service get funded only for the care they perform<sup>5</sup>. They do not get extra subsidies for equipments.

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3 Within public hospitals are included military hospitals, which in effect depends from another entity (the ministry of defence) but represent only 9 (out of 942 public hospitals) hospitals and 0.68% and 0.56% of the total number of registered nurses and nurse assistants.

4 <http://www.hopital.fr/Hopital/L-Hopital-comment-ca-marche/L-hopital-au-sein-de-l-organisation-generale-de-la-sante/Les-etablissements-de-sante-privs/Les-etablissements-de-sante-privs-a-but-non-lucratif> accessed November the 25<sup>th</sup> 2011.

5 Procedures performed by private hospitals not participating in the public service are, nevertheless, subject to authorisations by the regulatory body (which depends on the ministry of health).

### 2.3. Pay and employment

The definition of net wages differ between France and the common economic definition. Gross wage is the wage before any deductions and is therefore not the wage that employees receive every month or week in their bank accounts. The net wage, in economics, is the wage after tax and other statutory deductions. The net wage is the wage available for daily consumption and savings.

In France, the net wage is the wage after deductions of payments for social benefits (pensions, health insurance, unemployment benefits). The deductions differ between sectors, for example public sector workers do not contribute to unemployment insurance (Bartoli & Bras 2007) while this is deducted from private sector pay. Thus gross pay is not comparable across sectors. We follow Meurs & Edon (2007) who used “net”<sup>6</sup> pay, as they also compared pay between sectors to investigate the impact of pay in the private sector on pay in the public sector.

Non medical staff of public hospitals mainly have the status of civil servants, but hospitals may also hire staff under non statutory contracts. Private hospitals hire staff under the appropriate contracts for the private sector. They may be either, open ended contracts (Contrats à durée indéterminée) or fixed term contract (Contrats à durée déterminée).

Tables 1 and 2 summarise the statutory levels of pay for nurse assistants and registered nurses that are established in the two most important collective agreements covering hospitals in the private sector and the collective agreement that establishes pay in public sector hospitals. This information was extracted from collective agreements documents themselves. The two main collective agreements are covered: the FEHAP<sup>7</sup> which covers 70% of private not for profit hospitals and the FHP<sup>8</sup> which covers 90% of private for profit hospitals. For nurse assistants (Table 1), the best rate of pay when starting to work is within hospitals signing to the FEHAP collective agreement (8.41€, net salary). The best average annual progression (1.22) is obtained with the private for profit collective agreement (FHP). The best allowances for night shifts, Sunday and bank holidays pay are obtained for workers with the not for profit FEHAP collective agreement (4.3%/hour for night shifts 6.43€/hour for Sunday/bank holiday shifts). The public sector has the highest maximum progression over the career.

Table 1: Pay of nurse assistants: summary by collective agreements<sup>9</sup>

	Basic wage €/hour Gross	Basic wage €/hour Net	Annual progres- sion (average in %) <sup>10</sup>	Max. progres- sion end career in % <sup>10</sup>	Night shifts	Sunday, bank holiday shifts
Public	9.56	7.699	1.10	47	0.99 €/hour	5.61 €/hour
FEHAP	10.924	8.41	1.00	30 <sup>11</sup>	4.3 €/hour	6.43 €/hour
FHP	8.58	6.6	1.22	45	10% /hour	2.62 €/hour

Source: *Convention collective nationale des établissements privés d'hospitalisation, de soins, de cure et de garde à but non lucratif du 31 octobre 1951*, 31 October 1951 (Revised by Avenant n° 97-09 du 25 novembre 1997 BO conventions collectives 98-35), *Convention collective nationale de l'hospitalisation privée du 18 avril 2002*, 18 April 2002 and (Direction de l'Hospitalisation et de l'Organisation des Soins 2009).

6 As defined in France, gross pay minus social contributions but without deducting income tax.

7 A collective agreement for hospitals in the not for profit sector. Federation of not for profit hospital and private assistance premises (Federation des établissements hospitaliers et d'assistance privés à but non lucratif).

8 Collective agreement for for profit hospitals. Private federation of hospitals (Federation hospitalière privée).

9 The pay for hospitals covered by FEHAP is for the end of 2005. The pay for hospitals covered by FHP is for the 1<sup>st</sup> April 2007. The pay for public hospitals has been extracted from a document published in 2009.

10 Taking a fictive career of 30 years in the private sector, 35 years in the public for a person who climbs all the ladders.

11 Availability for local discretionary increases.

For registered nurses (Table 2), the starting wage is highest for employees in hospitals signing the FEHAP collective agreement, the maximum and average annual progression is better for public sector employees (73% and 1.58%), allowances for night shifts and Sunday/holiday shifts are highest in the not for profit hospitals covered by the FEHAP collective agreement.

Table 2: Pay of registered nurses: summary by collective agreements<sup>9</sup>

	Basic wage €/hour Gross	Basic wage €/hour Net	Annual progres- sion (average in %) <sup>10</sup>	Max. progres- sion end career in % <sup>10</sup>	Night shifts	Sunday, bank holiday shifts
Public	10.41	8.38	1.58	73	1 €/hour	5.61 €/hour
FEHAP	14.752	11.358	1	30 <sup>8</sup>	4.3 €/hour	6.43 €/hour
FHP	11.99	9.23	1.24	46	10% /hour	2.62 €/hour

Source: *Convention collective nationale des établissements privés d'hospitalisation, de soins, de cure et de garde à but non lucratif du 31 octobre 1951*, 31 October 1951 (Revised by Avenant n° 97-09 du 25 novembre 1997 BO conventions collectives 98-35), *Convention collective nationale de l'hospitalisation privée du 18 avril 2002*, 18 April 2002 and (Direction de l'Hospitalisation et de l'Organisation des Soins 2009).

The advantages of working in hospitals covered by the three different agreements also differ in other respects. Public sector hospitals have some advantages in terms of careers that can attract staff. Statutory contracts are life time ones. A household with one member having such a contract will have less difficulty obtaining a mortgage compared to a household with the same income without a contract in the public service. Public hospitals also have research activities in which nurses might become involved. Hospitals, participating in the public service have to receive all patients at any time which might be judged attractive, as it involves different and sometimes more challenging work, or it may be viewed as unattractive because it also involves less sociable hours<sup>12</sup>.

### 3. Data

Data on hospitals comes from the “Statistiques Annuelles des Etablissements de Santé” (SAE) which is a dataset available from the French ministry of health<sup>13</sup>. This data gives information on health care premises (“Etablissement de santé”) in France. All health care premises have to respond, it is a legal requirement, thus this data is exhaustive<sup>14</sup>. The ministry of health survey all hospitals (public, private not for profit or private for profit).

Data on pay comes from the “Déclarations Annuelles des Données Sociales” (DADS) which is an administrative data set which gives details of the pay and employment of all employees in all firms in France. Each year all companies are required to provide the fiscal and social administrations with the names of all their employees they had during the year and information on their sex, age, address, hours worked, position, qualification and the pay they received. The National Institute of Statistics and Economic Studies (INSEE, Institut National de la Statistique et des Études Économiques) check and validate the data.

The DADS data provides data on all the positions an individual held during the year (in the data an individual may be represented by more than one row). Two formats of this data exist, one which is exhaustive and which was used when analysing nurses only and the other which is a sample at 1 in 12 and which was used when analysing comparator groups of employees.

12 There are some variations in wage settings between different type of hospitals. Not all collective agreements are covered above, the main ones are however covered (FHP and FEHAP).

13 <http://www.sae-diffusion.sante.gouv.fr/> accessed the 2<sup>nd</sup> of November 2011.

14 <http://www.sante.gouv.fr/statistique-annuelle-des-etablissements-sae.html> accessed the 2<sup>nd</sup> of November 2011.

Three years are used, 2006-2007-2008; the choice of these three years is data driven; from 2006 we can distinguish between small groups of staff in the pay data. Only from 2006 onwards are registered nurses and nurse assistants easily distinguished from other group of carers such as social assistant.

Hospitals with no registered nurses or no nurse assistants have been excluded from the data. Those which are not in all the years (2006-2008) for which the analysis is undertaken have also been excluded. Overall the final dataset includes 942 public hospitals in each of the three years of interest (2006 to 2008), this gives a total of 2826 public hospitals. The change in staff mix over the period has been calculated by using one more year of data (2005). Only hospitals which do not change status over time have been kept (see Annex 1.).

The following subsection will present some raw statistics on the two datasets. The subsection 3.2 will describe how the array of variables measuring hospital size, hospital equipment and occupancy of beds were aggregated and summarised in a smaller number of variables. Subsection 3.3 describes those variables used as dependent variables in the empirical analysis (section 4 and 5). Subsection 3.4 describes the creation of standardised wages and wage gaps. Finally, the subsection 3.5 summarises and paves the way for the empirical section.

### 3.1. Descriptive statistics

Table 3 presents descriptive statistics for the data on hospitals by the status of hospitals. It shows that public hospitals appear to be larger for they employ more nurses and nursing assistants. While on average, there are 88 whole time equivalent (WTE) nursing assistants in each hospital, there are 190 WTEs in public hospitals but only 28 WTE nursing assistants in private not for profit and 25 WTEs in private for profit hospitals. Similar variations are observed for registered nurses: on average hospitals have 111 WTE registered nurses, public hospitals have 230 and private hospitals have around 39.

Public and private sector hospitals also differ in activity. Public hospitals are more likely to have medicine, surgery and obstetric (MSO), psychiatric and long stay wards than are either of the hospital types found in the private sector. The proportion of hospitals with MSO, psychiatric and long stay wards is 72%, 22% and 85% respectively, in the public sector while the shares are 29%, 7% and 67% respectively for private not for profit hospitals and 54%, 14% and 33% respectively for private for profit hospitals.

Some registered nurses have an extra diploma, for example for surgery theatres and are called specialised registered nurses. Hospitals have an average of 5% of specialised registered nurses in the total number of registered nurses they employ, and this varies little between hospitals of different status. Average pay differs by hospital status. Nursing assistants and registered nurses in public hospitals earn more on average than their private sector counterparts: 11.3€/hour and 14.2€/hour, respectively, compared to 10.02€/hour and 13.71€/hour in Private not-for-profit hospitals and 9.53€/hour and 13.35€/hour in Private for profit hospitals. However the differences are generally small, and they do not exceed two standard deviations, except for the difference between nursing assistants in public and private for profit hospitals.

Table 3: Descriptive statistics of hospitals and wage data

Variables	Hospitals	Mean	SD	P50	P10	P90
Nurse Assistants	Total	88.10	448.87	30.50	6.00	171.48
	Public	190.58	721.53	79.40	27.40	379.05
	Private not for profit	28.47	38.61	18.00	3.65	64.21
	Private for profit	25.79	26.46	16.80	4.30	58.28

Variables	Hospitals	Mean	SD	P50	P10	P90
Registered nurses	Total	110.86	473.44	24.08	6.50	255.74
	Public	230.81	756.07	59.70	10.25	523.16
	Private not for profit	39.73	68.27	13.17	4.00	110.10
	Private for profit	38.90	43.51	22.87	7.00	97.77
Staff-mix	Total	0.51	0.17	0.52	0.26	0.73
	Public	0.43	0.17	0.42	0.23	0.65
	Private not for profit	0.50	0.18	0.48	0.28	0.75
	Private for profit	0.59	0.13	0.59	0.42	0.75
Change in staff-mix	Total	0.005	0.11	0.00	-0.07	0.08
	Public	0.004	0.09	0.00	-0.07	0.08
	Private not for profit	0.008	0.14	0.00	-0.09	0.10
	Private for profit	0.005	0.10	0.00	-0.07	0.08
Medicine, Surgery and Obstetric	Total	0.54	0.50	1.00	0.00	1.00
	Public	0.72	0.45	1.00	0.00	1.00
	Private not for profit	0.29	0.45	0.00	0.00	1.00
	Private for profit	0.54	0.50	1.00	0.00	1.00
Psychiatric wards	Total	0.15	0.36	0.00	0.00	1.00
	Public	0.22	0.41	0.00	0.00	1.00
	Private not for profit	0.07	0.26	0.00	0.00	0.00
	Private for profit	0.14	0.34	0.00	0.00	1.00
Long stay wards	Total	0.61	0.49	1.00	0.00	1.00
	Public	0.85	0.36	1.00	0.00	1.00
	Private not for profit	0.67	0.47	1.00	0.00	1.00
	Private for profit	0.33	0.47	0.00	0.00	1.00
Share of Specialised nurses	Total	0.06	0.15	0.00	0.00	0.14
	Public	0.05	0.10	0.00	0.00	0.13
	Private not for profit	0.06	0.19	0.00	0.00	0.15
	Private for profit	0.06	0.16	0.00	0.00	0.22
Wages Nurse Assistants <sup>15</sup>	Public	11.33	0.74			
	Private not for profit	10.02	0.82			
	Private for profit	9.53	0.77			
Wages Registered Nurses <sup>15</sup>	Public	14.18	0.57			
	Private not for profit	13.71	0.58			
	Private for profit	13.35	0.62			

Source: SAE données administratives - ministère chargé de la santé, DREES, 2006-2008 and DADS, 2006-2008, INSEE

### 3.2. Hospital characteristics

Data on a wide variety of variables which distinguish the size of hospitals and the technologies that they employ is available. Both size and technology are judged to be determinants of the number and type of nurses hospitals employ: larger hospitals employ more nurses and more advanced technology requires more skilled nurses. Principal Component Analysis was therefore used to reduce the number of variables that would be employed in the linear regression analysis. Principal Component Analysis identifies linear combinations (components) that maximise the covariance within the variables. It aims to identify those components that are orthogonal (have a null correlation with) to the previous components and having done so each subsequent component therefore captures less variance than the previous one. In consequence a smaller number of compon-

<sup>15</sup> Percentiles were not extracted from the wage data.

ents than were initially identified will capture most of the covariance in the variables. PCAs are computed on three set of variables that are expected to measure similar concepts (Everitt & Dunn 2001, p.49)<sup>16</sup>.

The first set of variables distinguishes hospital size. The variables comprise the number of beds for complete care<sup>17</sup> and weekly stays at hospitals<sup>18</sup> (number of beds on a daily basis for the total year), the number of places for ambulatory surgery<sup>19</sup>, day care<sup>20</sup>, night care<sup>21</sup> and at home care<sup>22</sup>. The first two components of the PCA gathered most of the information contained in those six variables.

The second a set of variables distinguish the technology employed in the hospitals. These were: the number of scanners, MRI (Magnetic Resonance Imaging), gamma cameras, Positron emission tomography, lithotripter, diagnostic sonography (ultrasonography), number of non digital radiography rooms, number of digital radiography rooms, number of vascular radiography rooms, number of electrophysiology rooms, number of coronary catheterization rooms and number of rooms for functional explorations. Technology in some studies was found to be skilled intensive (Pope & Menke 1990; Acemoglu & Finkelstein 2008): the higher the technology the higher the need for skilled nurses. The first three components of a PCA ran on those variables gathered most of the information of those variables.

Finally, the level of activity is also measured. Therefore intensity is calculated by dividing the level of activity by the corresponding size variable<sup>23</sup>. The first three components of a PCA ran on those variables gathered most of the information in these variables.

Table 4 reports the variation of these components by status of hospital. A larger mean value for public hospitals indicates that hospitals scored high on the component and that therefore they have large values on corresponding original variables that are associated with the component. Public hospitals are always larger on the two components of size, private not for profit are larger than private for profit on the second component but not on the first. Public hospitals have, on average, larger values on the first and third components of equipment while they have on average the smallest values on the second component. Private not for profit hospitals have larger values on all components of equipments compared to private for profit. Public hospitals have larger values on the first component of the occupancy rates, and smaller ones on the second one. Private for profit hospitals have larger values on the second and third components of the occupancy rates.

Table 4: Descriptive statistics of PCA components

Variables	Hospitals	Mean	SD	P50	P10	P90
Size 1	Total	0.00	1.86	-0.41	-0.56	0.80
	Public	0.37	2.94	-0.36	-0.56	1.82
	Private not for profit	-0.27	0.54	-0.48	-0.56	0.22

16 Each variable has been centred and scaled to 0 so that all variables have the same weight.

17 Complete care is for heavy treatments that require the patient to stay at the hospital for a long period.

18 Week care is for patients who need to come for less than 5 days, usually from Monday to Friday.

19 Ambulatory surgery is for small surgeries that do not need patients to stay overnight.

20 Day care is for patients who come in the morning and leave during the same day. They do not stay overnight.

21 The night care is for patients who need to stay at the hospital overnight but have a daily activity outside the hospital.

22 The at home care is a scheme for people in terminal phases of illness that would require to be at the hospital. Hospitals make the care that they would need available from home.

23 The number of days realised in completes and week care is divided by the number of day-beds. The number of patients that have come for ambulatory surgery, day care, night care and at home care is divided by the number of places available in ambulatory surgery, day care, night care and at home care.

Variables	Hospitals	Mean	SD	P50	P10	P90
	Private for profit	-0.19	0.42	-0.35	-0.55	0.42
Size 2	Total	0.00	1.09	-0.04	-0.66	0.13
	Public	0.31	1.53	-0.03	-0.31	1.32
	Private not for profit	0.00	0.74	-0.03	-0.30	0.11
	Private for profit	-0.32	0.47	-0.07	-0.95	-0.02
Equipment 1	Total	0.00	2.17	-0.93	-0.93	2.27
	Public	0.44	2.67	-0.93	-0.93	4.00
	Private not for profit	-0.26	1.88	-0.93	-0.93	1.03
	Private for profit	-0.27	1.68	-0.93	-0.93	1.22
Equipment 2	Total	0.00	1.15	0.16	-0.75	0.16
	Public	-0.19	1.11	0.16	-1.31	0.16
	Private not for profit	0.15	1.49	0.16	-0.56	0.16
	Private for profit	0.09	0.82	0.16	-0.32	0.16
Equipment 3	Total	0.00	1.07	-0.17	-0.17	0.96
	Public	0.24	0.91	-0.17	-0.17	1.40
	Private not for profit	0.09	1.05	-0.17	-0.17	0.89
	Private for profit	-0.32	1.16	-0.17	-0.49	0.30
Occupation Rates 1	Total	0.00	1.19	-0.61	-0.69	1.45
	Public	0.23	1.43	-0.62	-0.68	2.35
	Private not for profit	-0.18	1.13	-0.65	-0.68	1.00
	Private for profit	-0.11	0.86	-0.28	-0.69	0.73
Occupation Rates 2	Total	0.00	1.06	-0.29	-0.49	1.28
	Public	-0.40	0.76	-0.35	-1.07	0.29
	Private not for profit	-0.14	1.20	-0.27	-0.44	0.51
	Private for profit	0.51	1.00	0.51	-0.44	1.80
Occupation Rates 3	Total	0.00	1.01	0.02	-0.37	0.66
	Public	-0.08	0.81	0.00	-0.49	0.52
	Private not for profit	-0.22	1.48	-0.06	-0.89	0.33
	Private for profit	0.24	0.68	0.06	-0.14	0.87

Source: SAE données administratives - ministère chargé de la santé, DREES, 2006-2008 and DADS, 2006-2008, INSEE

### 3.3. Dependent variables

This analysis explores whether hospital staffing levels are affected by the conditions in the local labour market in which the hospital is located. The measure of staffing levels is standardised by hospital size: staff numbers were standardised by the first component (rescaled to 1-100) of the size PCA. These standardised staffing levels are then used in the empirical section. When hospitals are unable to recruit all the staff they wish (to achieve the staffing levels they desire) hospitals may try to dampen the adverse effects by altering their skill mix. The skill mix as measured by the proportion of staff (and the change in staff mix as measured by its change over time) are therefore analysed in later sections of this paper.

Table 5 presents the descriptive statistics for the variables which measure staffing levels and skill mix for registered nurses and nursing assistants. The staffing levels of nursing assistants and registered nurses are approximately the same, on average, in public hospitals, however the staffing levels for registered nurses are higher than those for nursing assistants in private hospitals. There are also differences between hospitals in the same sector. Ten percent of public hospitals have less (more) than 22 (125) nurse assistants (10 (153) registered nurses). The proportion of registered nurses in the total number of registered nurses and nurse assistants is lower in public hospitals

(43%) than in private not for profit (50%) and private for profit (59%) hospitals. It is only at the  $10^{-3}$  level that it is possible to see any changes in proportion. Overall, hospitals have increased their proportions of registered nurses by 0.5%, with public hospitals increasing it by 0.4%, private not for profit hospitals by 0.8%, while private for profit hospitals increased theirs by an average of 0.5%.

Table 5: Descriptive statistics dependent variables

Variables	Hospitals	Mean	SD	P50	P10	P90
Nurse Assistants levels	Total	35.21	37.14	21.54	5.06	89.72
	Public	66.32	42.30	54.41	21.70	125.49
	Private not for profit	18.63	18.08	14.67	3.08	37.32
	Private for profit	15.17	11.06	12.61	3.79	30.39
Registered nurses levels	Total	38.58	45.93	18.77	5.82	106.55
	Public	65.48	60.01	41.45	9.63	153.27
	Private not for profit	23.03	28.86	11.00	3.61	63.88
	Private for profit	22.16	17.56	17.05	6.30	46.94
Staff-mix	Total	0.51	0.17	0.52	0.26	0.73
	Public	0.43	0.17	0.42	0.23	0.65
	Private not for profit	0.50	0.18	0.48	0.28	0.75
	Private for profit	0.59	0.13	0.59	0.42	0.75
Change in staff-mix	Total	0.005	0.11	0.00	-0.07	0.08
	Public	0.004	0.09	0.00	-0.07	0.08
	Private not for profit	0.008	0.14	0.00	-0.09	0.10
	Private for profit	0.005	0.10	0.00	-0.07	0.08

Source: SAE données administratives - ministère chargé de la santé, DREES, 2006-2008 and DADS, 2006-2008, INSEE

### 3.4. Standardising wage data

In France the pay of employees in public and private hospitals as well as in the private, non-hospital, sector is set by collective bargaining. Our analysis explores the impact of spatial variations in the competitiveness of nurses pay on spatial variations in nursing staff levels and skill mix in French hospitals. The competitiveness of nursing pay is distinguished by the gap between the pay of the two groups being compared. We distinguish three gaps:

- the differences between the pay of nurses (nurse assistants or registered nurses) in public hospitals and the pay of a comparator group working in the private non-hospital sector;
- the differences between the pay of nurses (nurse assistants or registered nurses) in public hospitals and the pay of nurses (nurse assistants or registered nurses) in hospitals in the not for profit private sector;
- the differences between the pay of nurses (nurse assistants or registered nurses) in public hospitals and the pay of nurses (nurse assistants or registered nurses) in hospitals in the for profit private sector.

The pay of nurses working in hospitals will be affected by whether they work full or part time, their age and perhaps their gender. Because the proportions working full time and the gender and age composition of the nursing workforce will differ between hospitals average pay levels will differ between hospitals and, because different hospitals are located in different areas, average pay will differ spatially. Pay in the private non hospital sector will also vary spatially because the occupational and industrial composition of the workforce will differ spatially. To distinguish the un-

derlying spatial structure of pay we therefore control for differences in the composition of the hospital workforce in each area.

Wages are standardised by calculating Standardised Spatial Wage Differentials (SSWDs). SSWDs are estimated from a wage equation and represent the parameters on to regional dummies (equation 1) where the equation includes controls for the above compositional effects. SSWDs are estimated for two groups of staff, nurse assistants and registered nurses in three hospital sectors: public, private not for profit, private for profit hospitals. SSWDs are also estimated for a further comparator group working in the private for profit non hospital sector. In this latter case the comparator group is defined as staff belonging to the same occupational code (Professions et Catégories Socioprofessionnelles) as nursing assistants or registered nurses<sup>24</sup>. The value of a SSWD in one region tells by how much the standardised wage differs from a reference (a département set up as the reference). Thus we estimate SSWDs as follows:

$$\begin{aligned}
 lh_{ikj} &= \alpha + x_{ij} * \beta + \gamma_j * \mu_k + \varepsilon_{ikj}, j = \text{Nurses Public sector PU} \\
 lh_{ikj} &= \alpha + x_{ij} * \beta + \gamma_j * \mu_k + \varepsilon_{ikj}, j = \text{Nurses Private not for profit PR} \\
 lh_{ikj} &= \alpha + x_{ij} * \beta + \gamma_j * \mu_k + \varepsilon_{ikj}, j = \text{Nurses Private for profit PP} \\
 lh_{ikj} &= \alpha + x_{ij} * \beta + \gamma_j * \mu_k + \varepsilon_{ikj}, j = \text{Comparator Private for profit PPC}
 \end{aligned} \tag{1}$$

*Equation 1: Equations for SSWDs estimation*

Where  $lh_{ikj}$  is the log of hourly earnings of individual  $i$  who works in  $j$  sector of the economy in area  $k$ . The vector  $x$  contains all the control variables (age, age-square, gender, industry dummies<sup>25</sup>, occupational dummies<sup>25</sup>, year dummies),  $\varepsilon_{ikj}$  are the individual-specific error terms and  $\mu_k$  are the area-specific effects and  $\gamma_j$  the associated vector of parameters. The area-specific effects represent the SSWDs and are estimated using a dummy variable for each area.

The gaps are then calculated as differences between two SSWDs estimated on a different sample for the same region (equation 2). The larger the gap the larger the difference between two SSWDs. The gap between two SSWDs reveals how much greater is the difference in SSWDs between the two staff groups compared to the reference. The mean of the gap, or any central statistic does not provide any information and when comparing two gaps, a difference in the means will reveal only that one of gaps is greater than the other when compared to the reference area.

$$\begin{aligned}
 \text{gap Nurses Public vs. Nurses Private not for profit} &= \text{PUSSWD} - \text{PRSSWD} \\
 \text{gap Nurses Public vs. Nurses Private for profit} &= \text{PUSSWD} - \text{PPSSWD} \\
 \text{gap Nurses Public vs. Private for profit} &= \text{PUSSWD} - \text{PPCSSWD}
 \end{aligned} \tag{2}$$

*Equation 2: Definition of gaps*

Where PUSSWD stands for the SSWD vector for nurses working in public sector hospitals, PR stands for nurses working in the private not for profit hospitals, PP stands for nurses working in the private for profit hospitals and PPC stands for the comparator group of employees outside hospital workers working in the private for profit sector.

### 3.5. Summary

There is a high level of coverage by collective agreement of French employees in the hospital and non hospital sectors. We therefore investigate the impact of outside wages (wages not paid by the sector being investigated) relative inside wage (the investigated one) on French hospitals. The French health care sector comprises different hospital sectors; public, private not for profit and private for profit. Thus for nurses there is a direct alternative to a job in the hospitals in the pub-

<sup>24</sup> For those employees, the data at 1:12<sup>th</sup> is used.

<sup>25</sup> Only for the comparator groups.

lic sector. The impact of pay in the alternative sectors (private not for profit, private for profit hospitals and in non nursing jobs) on the public hospital sector is investigated. The subsequent analysis will focus on the impact of variations in the spatial competitiveness of nurses pay on hospital staffing levels and the skill mix of the hospital nursing workforce.

These analyses will take into account the activity of the public hospitals. The descriptive statistics show that private hospitals (whether not for profit or for profit) differ from public hospitals in this respect. Therefore the analyses will control for activity and workforce<sup>26</sup> characteristics of private hospitals. The average activity and workforce characteristics of private not for profit (for profit) hospitals in each département are introduced in regressions.

## 4. Staff levels

This section will investigate the impact of the relative competitiveness of nursing pay on nurse staffing levels in French hospitals. The estimation strategy is to build from a simple model which regresses the staff level of nursing assistants (registered nurses) on the gap between the SSWD for this group and the SSWD for their comparator in the private non hospital sector, through to more sophisticated models which first explore the impact of the relative competitiveness of the pay of the other group of nurses (registered nurses in the case of nursing assistants and vice versa) and then introduce the range of covariates that are used to control for differences between hospitals in different départements and sectors. When staff levels are controlled by activity variables, it is expected that the variations in staff levels between different hospitals will proxy variations in shortage of staff.

### 4.1. Models for staff levels

The impact of wage gaps on the staffing levels of nurse assistants and registered nurses is investigated here. Firstly, the impact of the wage gap between the nurse assistants (registered nurses) SSWDs in public hospitals and the comparator group SSWDs in the private (non hospital) sector on the nurse assistants (registered nurses) level will be computed.

$$StaffLevel_{jk}^{N_1} = \alpha + \beta * gap_k^{N_1} + \varepsilon_{jk} \quad (3)$$

*Equation 3: Staff level simple model with just one gap*

Where  $StaffLevel_{jk}^{N_1}$  is the staff level of hospital  $j$  in département  $k$  for nurse assistants (or registered nurses).  $\alpha$  is the intercept of the model,  $\beta$  is the parameter for the  $gap_k^{N_1}$  which is the difference between the SSWD of the nurse assistants (registered nurses) and the one for the comparator group in the private sector of the département  $k$ .

Where registered nurses and nursing assistants are complementary in the production of hospital services the staffing levels for one group of nurses will likely affect the staffing levels of the other group. Accordingly we also explore whether the wage gap for registered nurses affects the staffing levels of nursing assistants and vice versa. In equation 4 the public hospitals minus private non hospital sector wage gap for qualified nurses is introduced into the estimating equation for nursing assistants. In this equation, there are two gaps, one for nurse assistants and one for registered nurses.

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<sup>26</sup> Workforce variables will include variables that are used as dependent ones for public hospitals, staff levels, proportion of registered nurses and its change over time.

$$StaffLevel_{jk}^{N_1} = \alpha + \beta_1 * gap_k^{N_1} + \beta_2 * gap_k^{N_2} + \varepsilon_{jk} \quad (4)$$

*Equation 4: Staff level model with two gaps*

Then covariates will be introduced in equation 5. Covariates include the type of activity performed in hospital j, and the equipment and occupancy rates as discussed earlier. Three dummies are introduced to control for differences between hospitals in the types of activity they undertake, where these have been defined as medicine, surgery and obstetric (MSO), long stay (LST), and psychiatry (PSY). The covariates also include the proportion of specialised registered nurses among the total number of registered nurses and controls for the technical procedures performed in the hospitals (the higher the value on this variable the more technical the procedures). The most important components from the several measures of type of equipment used in hospitals and hospital occupancy rates were identified by using PCAs. EQ1, EQ2 and EQ3, OccRate1, OccRate2 and OccRate3 and Size 2 are included in the estimation. Size 1 is not included because it is part of the dependent variable definition. The sign and size of the coefficients on the components of the PCA analysis will in some cases be difficult to predict. Equipments components should control for technical activities, thus the higher the value on those components the more skilled the staff should be. Higher levels of registered nurses should be expected and lower levels of nurse assistants. In the case of the second component of size, the effect is difficult to predict as it captures hospital with a larger size in day care and night care and a lower size in ambulatory surgery for higher values on this component. Hospitals with high occupancy rates are expected to have higher levels of staff to deal with higher throughput.

$$StaffLevel_{jk}^{N_1} = \alpha + \beta_1 * gap_k^{N_1} + \beta_2 * gap_k^{N_2} + \beta_3^C * X_{jk}^C + \varepsilon_{jk} \quad (5)$$

*Equation 5: Staff level model with activity variables*

So far the full advantages of the French hospital setting is not used. In the next two models, average characteristics of private sectors hospitals are introduced. First, average of nursing staff level, staff mix, activity, share of specialised registered nurses, components of the PCAs (not for profit, PR, and for profit, PP) are introduced in equation 6. These variables includes the average of the staff levels (both nurse assistants and registered nurse), the average proportion of registered nurses, the change in the proportion, the proportion of hospitals with wards in medicine, surgery and obstetric (MSO PR<sup>27</sup> and MSO PP<sup>27</sup>), in psychiatry (PSY PR<sup>27</sup> and PSY PP<sup>27</sup>), in long stays (LST PR<sup>27</sup> and LST PP<sup>27</sup>), the mean values of the share of specialised registered nurses, and of the components of the different PCA for private not for profit and private for profit hospitals. The parameters of those variables will be presented only if significant at least at the 5% level.

$$StaffLevel_{jk}^{N_1} = \alpha + \beta_1 * gap_k^{N_1} + \beta_2 * gap_k^{N_2} + \beta_3^C * X_{jk}^C + \beta_4 * DeptZPR_k + \beta_5 * DeptZPP_k + \varepsilon_{jk} \quad (6)$$

*Equation 6: Staff level model with activity variables, private sector variables*

Where PR stands for private not for profit and PP for private for profit and Z is the matrix for the variables averaged at the département level.

Finally in the estimation of equation 7 we replace the gaps included above by the ones which are measuring the difference in the SSWDs between nurses working in the public sector and nurses working in the private not for profit and for profit sectors. Equation 7 is thus taking fully advantage of the alternative employers available for nurses in France. This equation takes into account the characteristics of alternative hospitals (private not for profit and private for profit) and the gap in SSWDs between public sector nurses and private (not for profit and for profit) hospitals.

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27 Where PR stands for private not for profit and PP for private for profit.

$$StaffLevel_{jk}^{N_1} = \alpha + \beta_1 * gapPUvsPR_k^{N_1} + \beta_2 * gapPUvsPP_k^{N_1} + \beta_3 * gapPUvsPR_k^{N_2} + \beta_4 * gapPUvsPP_k^{N_2} + \beta_5^C * X_{jk}^C + \beta_6 * DeptZPR_k + \beta_7 * DeptZPP_k + \varepsilon_{jk} \quad (7)$$

Equation 7: Staff level model with gaps comparing nurses across sectors, activity variables, private sector activity and workforce variables

Where PR stands for private not for profit and PP for private for profit, PU for public and Z is the matrix for the variables averaged at the département level.

#### 4.2. Results for staff levels

Table 6 presents the results for equation 3, 4 and 5 for nurse assistants and registered nurses. Gaps are not significant in models 3 and 4. There is no impact of the gap between the nurse assistants SSWD and the comparator group SSWD on the number of nurse assistants per unit of size. The same applies for the registered nurses gap on the number of nurse assistants per unit of size.

There is no impact of the gap between the registered nurses SSWD and the comparator group SSWD on the number of registered nurses per unit of size. The same applies for the nurse assistants gap on the number of registered nurses per unit of size.

Equation 5 controls for activity variables.

For nurse assistants levels the parameter of the gap for nurse assistants increase compared to the other two models from 1.2 to 4.1 and becomes significant showing that hospitals which are in départements with higher gaps tend to have a higher staffing level of nurse assistants.

For registered nurses introducing the activity variables make the gap for nurse assistant significantly different from 0 and positive. An increase in the gap (SSWDs for nurse assistants is getting relatively larger compared to the comparator group) increases the level of staffing of registered nurses.

Activity variables for equation 5 are highly significant in both nurse assistants and registered nurses level models. Except for long stay wards (LST) all the other variables share the same sign and significance. Hospitals with long term stay wards have on average a higher level of nurse assistants. Hospitals with medicine, surgery and obstetric wards have on average 21 nurse assistants (15 registered nurses) per unit of size more than those without, hospitals with a psychiatric unit have seven nurse assistants (43 registered nurses) per unit of size more on average. Hospitals with a share of specialised nurses of 5% (the descriptive statistics show that on average public hospitals have 5% of specialised nurses) have two (40\*5%, where 40 is the value of the parameter) more nurse assistants (3.5 registered nurses) on average. The first and third components of equipment PCA shows that hospitals which have a higher value on the component tend to get more nurse assistants. The second component of Size has a negative parameter, showing that those hospitals have lower nurse assistants levels when they tend to have more day care and night care places and higher levels of nurse assistants when hospitals have more ambulatory surgery places. The three components of the occupation rates PCA have positive parameters. The higher the occupancy rate, the higher the level of nurse assistants.

Table 6: Results for equation 3, equation 4 and equation 5 staff levels

	Nurse Assistants						Registered nurses					
	Eq. 3		Eq. 4		Eq. 5		Eq. 3		Eq. 4		Eq. 5	
	Est.	P	Est.	P	Est.	P	Est.	P	Est.	P	Est.	P
Intercept	65.686***	<0.001	65.686***	<0.001	37.836***	<0.001	65.476***	<0.001	65.476***	<0.001	44.670***	<0.001

	Nurse Assistants						Registered nurses					
	Eq. 3		Eq. 4		Eq. 5		Eq. 3		Eq. 4		Eq. 5	
	Est.	P	Est.	P	Est.	P	Est.	P	Est.	P	Est.	P
NA Gap	1.1860	0.410	1.2393	0.490	4.1480***	<0.001			-2.547	0.302	2.4755*	0.063
RN Gap			-0.080	0.962	-1.621	0.192	-3.044	0.108	-1.368	0.587	-0.676	0.614
MSO					21.332***	<0.001					15.189***	<0.001
PSY					6.9608**	0.031					43.052***	<0.001
LST					12.785***	<0.001					-3.755	0.298
Sh. Nur. Spe.					39.831***	<0.001					71.300***	<0.001
Eq 1					2.5786***	<0.001					4.2069***	<0.001
Eq 2					-0.126	0.874					-0.269	0.821
Eq 3					2.1550**	0.041					3.2183**	0.028
Size 2					-5.418***	<0.001					-2.645***	0.001
OccRate 1					13.305***	<0.001					21.894***	<0.001
OccRate 2					10.568***	<0.001					16.479***	<0.001
OccRate 3					3.9122***	0.002					6.1245***	<0.001

Source: SAE données administratives - ministère chargé de la santé, DREES, 2006-2008 and DADS, 2006-2008, INSEE

Table 8 (Annex 2) presents results for nurse assistants and registered nurses staff levels for equations 6 and 7 (along with results of equation 5 in order to compare).

Equation 6 includes variables at the département level which summarise information for private not for profit and private for profit hospitals. None of the variables are significantly different from 0 in the nurse assistants model, thus not included in the table. However, including those variables reduced the size of the parameter for the nurse assistants gap compared with equation 5 and is still significant. Thus globally the variables summarising characteristics of the private not for profit and private for profit hospitals capture some of the effect of the gap.

Only one variable from the private not for profit sector are significant in equation 6 for registered nurses. When the proportion of registered nurses has increased over the previous year in the private not for profit sector, then the level of registered nurses in public hospitals is higher. The gap for nurse assistants which was significant in model of equation 5 is not significant any more, therefore, overall there is an effect of variables summarising characteristics of the private not for profit and private for profit hospitals. They capture some of the effect of the gap.

Equation 7 replace the gaps defined as the difference between the SSWD for nurses working in the hospitals public sector and a comparator group working in the private non hospital sector by gaps defined as the SSWDs for nurses working in the hospitals public sector and nurses working in the hospitals private not for profit sector and nurses working in the private for profit sector. None of those four gaps (one for each group of staff, and for the two sectors) are significant in any of the two models (nurse assistants and registered nurses).

#### 4.3. Conclusion

This section analysed the impact of the competitiveness of nursing pay on staff levels. Staff levels once adjusted for activity, following Grumbach et al. (2001), can serve as a measure of staff shortage. The lower the level of staff (activity adjusted), the greater the shortage. Controlling for activity is important as some activities might be more labour intensive than others and therefore requiring higher staff levels. The difference in SSWDs between nurse assistants working in public hospitals and their comparator group working in the non hospital private sector has an impact on

nurse assistants staff levels. The higher the gap, the higher the staff level of nurse assistants. In any département a higher gap means that the SSWD for nurse assistants working in hospitals in the public sector is relatively higher than in other regions. The results reveal that, in those départements in which the standardised wage (SSWD) for nurse assistants in public sector hospitals is relatively higher compared to the comparator group, public hospitals have higher staffing levels and a smaller shortage of nurse assistants. While recognising the inherent weaknesses of any model, it is possible to conclude that spatial variations in the shortage in nurse assistants in public hospitals in France are due to differences in the relative competitiveness of nursing assistants pay, to differences in the standardised pay gap (as measured by differences in SSWDs).

Other results regarding the gaps effect on nurses staffing levels include the impact of the nurse assistants gap (the difference between the nurse assistants SSWD in the hospital public sector and their comparator group in the private sector) on the staffing levels of registered nurses. Though this effect is not robust to the introduction of alternative hospital sectors characteristics (private not for profit and private for profit). Finally, the competitiveness of pay as measured by the gaps constructed using the SSWDs in the private (not for profit and for profit) hospitals do not have any impact on staff levels. Thus it is possible to conclude that the competitiveness of the wages offered by direct alternative employers of nursing staff have no impact on public sector shortages. The results must be treated with caution, because, first, staff levels may not measure shortage perfectly and second our models may not control for all that is relevant.

## 5. Proportion of registered nurses and variations over time

In the previous section, staffing levels were analysed. The previous section concluded that the gap for nurse assistants, defined as the difference between SSWDs for nurse assistants working in the public sector and their comparator group, had an impact on variations in the staffing levels of nurse assistants. It also concluded that the level of registered nurses was not affected by wage gaps and that standardised wages offered by alternative employers do not affect staffing levels and shortages in hospitals in the public sector.

This section analyses the impact of the same gaps on skill mix and the change in skill mix during the period studied. Where hospitals are unable to achieve the staffing levels they desire, where they are facing a shortage of nurses they might seek to alter the skill mix of the nursing staff. If hospitals are unable to recruit the numbers of registered nurses or nursing assistants they require they may seek to sustain hospital services by changing the hospital skill mix. This will of course depend on their ability to recruit the nurse assistants or registered nurses to change skill mix. The proportion of registered nurses and the variations in this proportion will be analysed here.

### *5.1. Models for the proportion of registered nurses and its change over time*

In this section we shall analyse the skill mix of the nursing workforce, where the skill mix is defined as the proportion of registered nurses in the nursing workforce, and the nursing workforce comprises registered nurses, RN, plus nursing assistants, NA. Thus the proportion is  $RN/RN+NA$ . The impact of relative competitiveness of nursing pay, as measured by the wage gaps, on the proportion of registered nurses and on the change in this proportion over time is investigated here.

The gaps for the two groups of nursing staff (nurse assistants and registered nurses) are introduced together. As for staff levels, the gaps are defined as the difference between the SSWDs for nurses in the public hospital sector and SSWDs for the comparator group in the non hospital

private sector.

Equation 8 tests for the introduction of this gap (public hospitals minus private non hospital sector) for the two groups of the nursing staff. In this equation, there are two gaps, one for nurse assistants and one for registered nurses.

$$Proportion_{jk}^{N_1} = \alpha + \beta_1 * gap_k^{N_1} + \beta_2 * gap_k^{N_2} + \varepsilon_{jk} \quad (8)$$

*Equation 8: Proportion model with two gaps*

Where  $Proportion_{jk}$  is either the proportion of registered nurses or its change over time.  $\alpha$  is the intercept of the model,  $\beta_1$  is the parameter for the  $gap_k^{N_1}$  which is the difference between the SSWD of the nurse assistants and the one for the comparator group in the private sector of the département  $k$ .  $\beta_2$  is the parameter for the  $gap_k^{N_2}$  which is the difference between the SSWD of the registered nurses and the one for the comparator group in the private sector of the département  $k$ .

Then covariates will be introduced in equation 9. Hospital occupancy rates are likely to affect skill mix. Where a hospital has high occupancy rates but is unable to attain the staffing levels it requires in some grades we would expect it to explore the opportunities for employing other grades of staff to substitute for those it is unable to recruit. Technology will also be a determinant of skill mix. The more technologically advanced is the hospital equipment the higher the proportion of skilled staff.

$$Proportion_{jk} = \alpha + \beta_1 * gap_k^{N_1} + \beta_2 * gap_k^{N_2} + \beta_3^C * X_{jk}^C + \varepsilon_{jk} \quad (9)$$

*Equation 9: Proportion model with activity variables*

The full advantages of the French data is realised in the two last models, where the regional (at département level) average characteristics for private sectors hospitals are introduced: average of nursing staff level, staff mix, activity, share of specialised registered nurses, components of the PCAs (not for profit, PR, and for profit, PP). Equation 10 will introduce those regional average characteristics: average of the staff levels (both nurse assistants and registered nurses), average of the proportion of registered nurses, average of the change in the proportion, average of the proportion of hospitals with wards in medicine, surgery and obstetric (MSO PR<sup>28</sup> and MSO PP<sup>28</sup>), in psychiatry (PSY PR<sup>28</sup> and PSY PP<sup>28</sup>), in long stays (LST PR<sup>28</sup> and LST PP<sup>28</sup>), the mean values of the share of specialised registered nurses, and of the average of components of the different PCA of private not for profit and private for profit. The parameters of those variables will be presented only if significant at least at the 5% level.

$$Proportion_j = \alpha + \beta_1 * gap_k^{N_1} + \beta_2 * gap_k^{N_2} + \beta_3^C * X_j^C + \beta_4 * DeptZPR_j + \beta_5 * DeptZPP_j + \varepsilon_j \quad (10)$$

*Equation 10: Proportion model with activity variables, private sector variables*

Where PR stands for private not for profit and PP for private for profit and Z is the matrix for the variables averaged at the département level.

Finally the model estimated in equation 11 will replace the gaps included above by the ones which measure the difference in the SSWDs between nurses working in the public sector and nurses working in hospitals in the private not for profit and for profit sector. Equation 11 thus takes full advantage of the alternative employers available for nurses in France. This equation takes into account the characteristics of alternative hospitals (private not for profit and private for profit) and the gap in SSWDs between public sector nurses and private (not for profit and for profit) hospit-

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28 Where PR stands for private not for profit and PP for private for profit.

als.

$$\begin{aligned} \text{Proportion}_j^{N_1} = & \alpha + \beta_1 * \text{gapPUvsPR}_k^{N_1} + \beta_2 * \text{gapPUvsPP}_k^{N_1} + \beta_3 * \text{gapPUvsPR}_k^{N_2} \\ & + \beta_4 * \text{gapPUvsPP}_k^{N_2} + \beta_5^C * X_j^C + \beta_6 * \text{DeptZPR}_j + \beta_7 * \text{DeptZPP}_j + \varepsilon_j \end{aligned} \quad (11)$$

Equation 11: Proportion model with gaps comparing nurses across sectors, activity variables, private sector activity and workforce variables

Where PR stands for private not for profit and PP for private for profit, PU for public and Z is the matrix for the variables averaged at the département level.

## 5.2. Results for the proportion of registered nurses

Table 7 presents the results for equation 8 for the proportion of registered nurses and its change over time. In départements where the gap for nurse assistants is larger (the SSWD for nurse assistants is relatively higher compared to SSWD for the comparator group in the private non hospital sector), the proportion of registered nurses is relatively lower, or the proportion of nurse assistants relatively larger. The gaps are not significant in any of the change models.

Equation 9 controls for differences between hospitals in activity. For the proportion of registered nurses model, the gaps are significant in this setting, the nurse assistants gap has a negative parameter, hospitals in départements where the SSWD for nurse assistants is larger relative to the comparator group working in the private non hospital sector have a larger proportion of nurse assistants (lower proportion of registered nurses). Hospitals in départements where the SSWD for registered nurses is relatively larger than the comparator group working in the private non hospital sector have a larger proportion of registered nurses. For the change in proportion, the gaps are not significant in those models.

In the proportion models, most of activity variables are significant. Hospitals with medicine, surgery and obstetric wards do not have a larger proportion of any of the nurses group compared to hospitals with none of those wards. Hospitals with psychiatric wards have a larger proportion of registered nurses and hospitals with long stay have a higher proportion of nurse assistants. Hospitals with a larger share of specialised nurses tend to have a higher proportion of registered nurses. All the components of the PCAs except the second component of equipment have parameters that are positive; thus hospitals with larger values on these components are associated with hospitals with larger proportion of registered nurses. This was expected for equipment components (at least the first one) as it has been shown elsewhere that the technology is skill intensive (Pope & Menke 1990; Acemoglu & Finkelstein 2008), it was also expected for the size component as in Czuber-Dochan et al. (2006).

In the change model hospitals with a psychiatric ward have a lower increase in the proportion of registered nurses. Hospitals with higher values on the second component of size have a lower increase in the proportion of registered nurses.

Table 7: Results for proportion of staff, only gaps introduced

	Proportion of Registered Nurses				Change in the proportion of registered nurses			
	Eq. 8		Eq. 9		Eq. 8		Eq. 9	
	Estimate	Pvalue	Estimate	Pvalue	Estimate	Pvalue	Estimate	Pvalue
Intercept	0.4301***	0.00	0.4344***	3.883	0.0039***	0.004	0.0133**	0.041
NA Gap	-0.019***	0.005	-0.011***	0.008	0.0026	0.160	0.0027	0.142
RN Gap	-0.002	0.695	0.0080*	0.055	-0.002	0.266	-0.002	0.264
MSO			-0.005	0.565			-0.006	0.139

	Proportion of Registered Nurses				Change in the proportion of registered nurses			
	Eq. 8		Eq. 9		Eq. 8		Eq. 9	
	Estimate	Pvalue	Estimate	Pvalue	Estimate	Pvalue	Estimate	Pvalue
PSY			0.1441***	<0.001			-0.004**	0.025
LST			-0.070***	<0.001			-0.003	0.571
Sh. Nur. Spe.			0.1390***	0.006			-0.003	0.825
EQ 1			0.0073***	<0.001			0.0003	0.181
EQ 2			-0.003	0.326			0.0002	0.658
EQ 3			0.0241***	<0.001			-0.000	0.336
Size 1			0.0031***	0.003			0.0000	0.505
Size 2			0.0256***	<0.001			-0.001***	0.001
OccRate 1			0.0373***	<0.001			-0.000	0.354
OccRate 2			0.0301***	<0.001			-0.000	0.829
OccRate 3			0.0082**	0.044			0.0009	0.298

Source: SAE données administratives - ministère chargé de la santé, DREES, 2006-2008 and DADS, 2006-2008, INSEE  
NA stands for nurse assistants and RN stands for registered nurses

Table 9 (See annex 2.) presents the results for equation 10 and 11 for the proportion of registered nurses and its change over time along with results of equation 9 in order to compare.

Equation 10 introduced variables capturing the private not for profit and for profit hospitals characteristics at the département level. In the proportion model the introduction of those variables change the significance of the nurse assistants gap, which is now not significant. However the registered nurses gap remains significant at an even higher level (5% against 10%). In the change in the proportion model, the introduction of these variables does not change the gaps significance. Among the activity variables, only the second component of size remained significant in the change model.

Some of the variables summarising the characteristics of the private not for profit and for profit hospitals at the département level are significant at the 5% level in the proportion model. Public hospitals which have private not for profit hospitals in their area which have higher levels of nurse assistants (registered nurses) have a higher proportion of nurse assistants (registered nurses). Public hospitals which are situated in départements where private not for profit hospitals participate in the public service have a higher proportion of registered nurses. Public hospitals have lower proportions of registered nurses in départements where private for profit hospitals have large values on the first component of the occupancy PCA and on the second component of the equipment PCA.

For the change model, two variables characterising the private for profit hospital are significant. Public hospitals in départements where private for profit hospitals have more long stay ones tend to have a lower growth rate of the proportion of registered nurses. Public hospitals in département where size of private for profit hospitals is larger tend to have a lower growth of proportion of registered nurses.

Equation 11 replaced the gaps defined as differences between SSWDs for nurses in the public sector with their comparator group working in the private sector with the gaps for differences in SSWDs between nurses in the public sector and nurses in hospitals private not for profit and for profit hospitals. In the proportion model the gaps are not significant. However, the level of registered nurses in private not for profit hospitals is not significant any more.

The gap defined as the difference between the registered nurses SSWD working in the public sector and the registered nurses SSWD working in the private not for profit sector is significant in the change model. It shows that when public sector registered nurses have a relatively better SSWD compared to registered nurses working in the private not for profit sector, public hospitals have a lower growth of the proportion of registered nurses.

### 5.3. Conclusion

This section has tested for changes in skill mix where this change is one response open to hospitals facing a shortage of one group of staff. Changing the proportion of registered nurses could happen in situations where hospitals are in départements in which the gap, defined as the difference between the SSWD for nurses compared to the SSWD for the comparator groups, is relatively lower than the the same gap in other départements. Thus a lower gap for registered nurses might be associated with a lower proportion of registered nurses. This is observed in the results for equations 9 and 10. Public hospitals in départements where the gap for registered nurses is larger have higher proportions of registered nurses. However, this result is not observed for the change in the proportion of registered nurses. The gap for nurse assistants is observed as having an effect on the proportion of registered nurses only up to equation 9. The variables controlling for the activity in alternative hospitals capture the effect of this gap later on (equation 10). Therefore, it is possible to conclude, with the necessary precautions, that public hospitals with less difficult labour market conditions (nurses gap are larger) tend to modify their staff mix following the group of staff for which gaps are the larger. The gaps with alternative employers (hospitals in private not for profit and private for profit) are not significant. Thus public hospitals do not adapt their staff mix according to standardised wages in the other hospital sectors.

Except for one equation (11), the growth in the proportion for registered nurses is not affected by gaps. In this equation 11, the public hospitals in which the gaps for registered nurses is larger have lower growth of proportion of registered nurses. When the gap is smaller, there is an increase in the proportion of registered nurses.

## 6. Discussions and conclusion

The analysis above has produced mixed results. While in many cases the the competitiveness of nursing pay in public sector hospitals - the wage gap between hospitals in the public sector and hospitals in the private sector (not for profit and for profit) - does not have any impact on the staff levels and nursing staff mix in public hospitals there are some cases where it does. Wage gaps between hospitals in the public hospital sector and the private sector are significant in a number of regressions. They show that public hospitals react to and are affected by wage gaps. It is possible to conclude that variations in the shortage in nurse assistants in public hospital is due to relative difference in standardised pay (as measured by SSWD). Staff mix is also affected by wage gaps. Hospitals in the public sector alter their staff-mix according to wage gaps. When gaps are larger for nurse assistants, the staff mix will favour nurse assistants.

Further activity is shown to have an impact on staff levels and on proportion of staff. Private not for profit staff levels were found to have an impact on the proportion of registered nurses in public hospitals. Activity variables of private hospitals (not for profit and for profit) also have an impact on hospitals in the public sector.

The estimates of the determinants of the changes in skill mix was not very conclusive. Further research will investigate the impact of other variables that would measure the reaction of public

hospitals when facing difficult wage gaps.

Another measure of shortage would also enhance this paper. Staff levels are a weak measure of shortage. This variable is as only as good as its ability to control for differences in hospital. More sophisticated measures of activity might include diagnosed related groups (DRGS). Obtaining this data is possible, however, such a study would have to reduce its scope to focus only on acute hospitals.

Finally, it would be of interest to run a similar analysis for private hospitals in order to assess the impact of public sector wages on private sector workforce.

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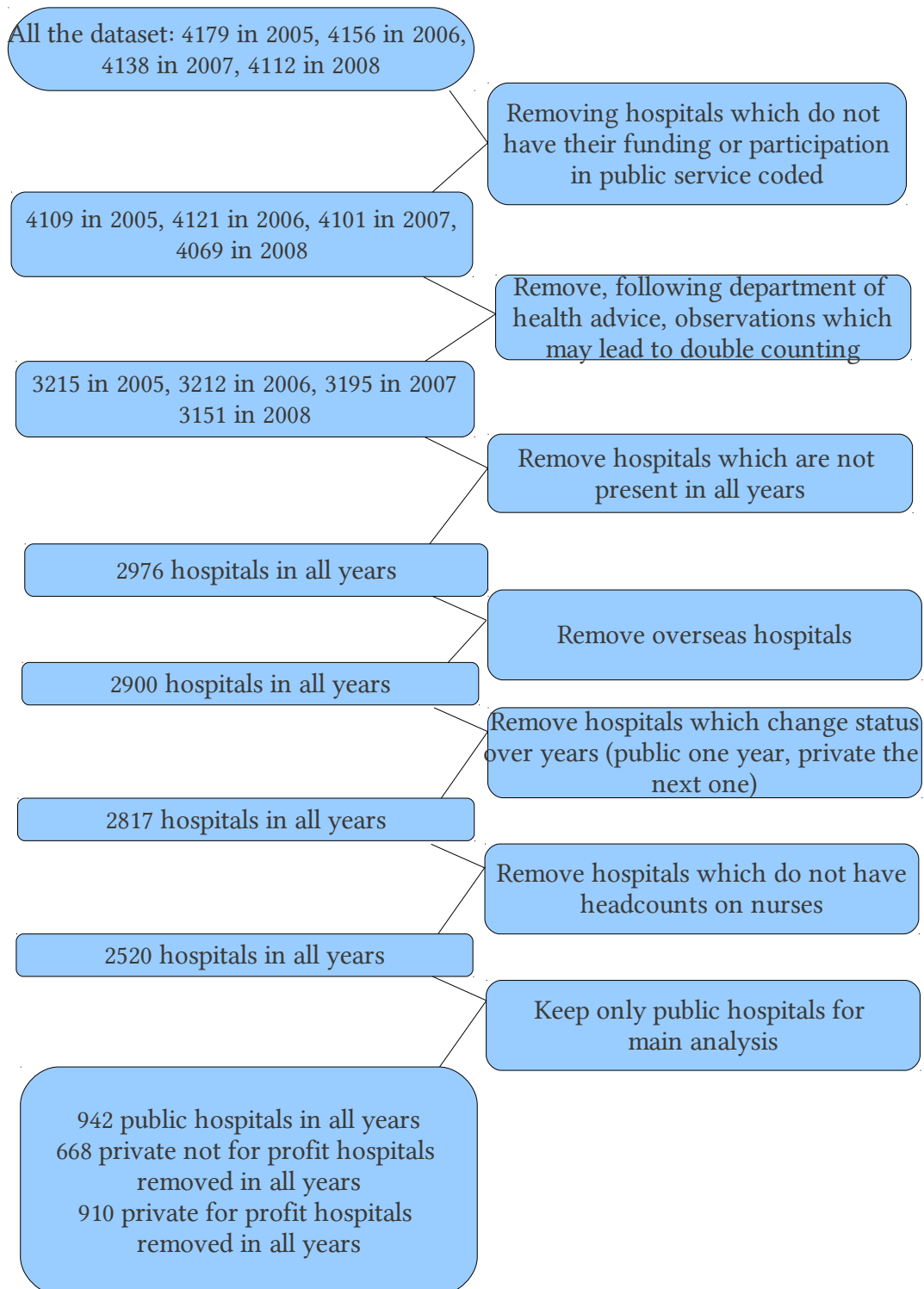
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## 1. Flow diagram



## 2. Tables

Table 8: Nurse Assistants levels, results of equations 5, 6 and 7

	Nurse assistants						Registered nurses					
	Eq. 5		Eq. 6		Eq. 7		Eq. 5		Eq. 6		Eq. 7	
	Est.	Pvalue	Est.	Pvalue	Est.	Pvalue	Est.	Pvalue	Est.	Pvalue	Est.	Pvalue
Intercept	37.836***	<0.001	17.710***	0.002	20.572***	<0.001	44.670***	<0.001	23.562***	0.001	27.853***	<0.001
NA Gap	4.1480***	<0.001	3.1590**	0.044			2.4755*	0.063	2.2677	0.224		
RN Gap	-1.621	0.192	-0.477	0.768			-0.676	0.614	1.9079	0.254		
NA Gap PU vs PR					-0.335	0.725					-0.094	0.932
RN Gap PU vs PR					0.2973	0.739					-0.244	0.803
NA Gap PU vs MA					1.2184	0.240					1.6085	0.183
RN Gap PU vs MA					-1.198	0.214					-1.798	0.143
MSO	21.332***	<0.001	21.272***	<0.001	21.266***	<0.001	15.189***	<0.001	16.143***	<0.001	16.525***	<0.001
PSY	6.9608**	0.031	6.1638*	0.053	5.9027*	0.064	43.052***	<0.001	44.027***	<0.001	43.716***	<0.001
LST	12.785***	<0.001	12.119***	<0.001	12.366***	<0.001	-3.755	0.298	-4.210	0.250	-3.667	0.318
Share Nurse Specialist	39.831***	<0.001	39.007***	<0.001	39.729***	<0.001	71.300***	<0.001	67.817***	<0.001	68.408***	<0.001
Equipment 1	2.5786***	<0.001	2.5024***	<0.001	2.4537***	<0.001	4.2069***	<0.001	4.4328***	<0.001	4.3675***	<0.001
Equipment 2	-0.126	0.874	-0.158	0.843	-0.095	0.906	-0.269	0.821	-0.698	0.560	-0.560	0.645
Equipment 3	2.1550**	0.041	2.2102**	0.036	2.2982**	0.030	3.2183**	0.028	3.1169**	0.031	3.1019**	0.032
Size 2	-5.418***	<0.001	-5.524***	<0.001	-5.372***	<0.001	-2.645***	0.001	-2.855***	<0.001	-2.648***	0.001
OccRate 1	13.305***	<0.001	13.320***	<0.001	13.299***	<0.001	21.894***	<0.001	21.555***	<0.001	21.495***	<0.001
OccRate 2	10.568***	<0.001	10.690***	<0.001	10.881***	<0.001	16.479***	<0.001	15.692***	<0.001	15.975***	<0.001
OccRate 3	3.9122***	0.002	3.9064***	0.001	3.8996***	0.001	6.1245***	<0.001	6.3580***	<0.001	6.4074***	<0.001
Prop growth rate PR									22.329**	0.010	23.723***	0.006

Source: SAE données administratives - ministère chargé de la santé, DREES, 2006-2008 and DADS, 2006-2008, INSEE

PR stands for private not for profit, PP stands for private for profit and PU stands for public. NA stands for nurse assistants and RN stands for registered nurses.

Table 9: Proportion of registered nurses and change in proportion models, results of equations 9, 10 and 11

	Proportion of registered nurses						Change in the proportion of registered nurses					
	Eq. 9		Eq. 10		Eq. 11		Eq. 9		Eq. 10		Eq. 11	
	Est.	Pvalue	Est.	Pvalue	Est.	Pvalue	Est.	Pvalue	Est.	Pvalue	Est.	Pvalue
Intercept	0.4344***	3.883	0.4578***	<0.001	0.4626	<0.001	0.0133**	0.041	0.0045	0.744	0.0036	0.783
Nurse Assistants Gap	-0.011***	0.008	-0.007	0.201			0.0027	0.142	-0.011	0.611		
Registered Nurses Gap	0.0080*	0.055	0.0125**	0.011			-0.002	0.264	-0.107	0.297		
NA Gap PU vs PR					0.0004	0.872					0.0025	0.189
RN Gap PU vs PR					0.0000	0.990	0.0133**	0.041			-0.003*	0.058
NA Gap PU vs MA					0.0035	0.338	0.0027	0.142			0.0011	0.641
RN Gap PU vs MA					-0.002	0.456	-0.002	0.264			-0.000	0.888
MSO	-0.005	0.565	-0.003	0.697	-0.001	0.842	-0.006	0.139	-0.006	0.177	-0.005	0.180
PSY	0.1441***	<0.001	0.1505***	<0.001	0.1508***	<0.001	-0.004**	0.025	-0.003	0.115	-0.003	0.116
LST	-0.070***	<0.001	-0.071***	<0.001	-0.070***	<0.001	-0.003	0.571	-0.002	0.723	-0.002	0.730
Share Nurse Specialist	0.1390***	0.006	0.1325***	0.005	0.1328***	0.006	-0.003	0.825	-0.000	0.976	-0.001	0.952
Equipment 1	0.0073***	<0.001	0.0082***	<0.001	0.0082***	<0.001	0.0003	0.181	0.0003	0.292	0.0003	0.236
Equipment 2	-0.003	0.326	-0.004	0.148	-0.004	0.191	0.0002	0.658	0.0003	0.545	0.0001	0.792
Equipment 3	0.0241***	<0.001	0.0226***	<0.001	0.0221***	<0.001	-0.000	0.336	-0.000	0.692	-0.000	0.583
Size 1	0.0031***	0.003	0.0027***	0.009	0.0027**	0.011	0.0000	0.505	0.0001	0.322	0.0001	0.414
Size 2	0.0256***	<0.001	0.0249***	<0.001	0.0250***	<0.001	-0.001***	0.001	-0.001	0.014**	-0.001**	0.02
OccRate 1	0.0373***	<0.001	0.0352***	<0.001	0.0350***	<0.001	-0.000	0.354	-0.000	0.394	-0.000	0.382
OccRate 2	0.0301***	<0.001	0.0266***	<0.001	0.0270***	<0.001	-0.000	0.829	-0.000	0.721	-0.000	0.579
OccRate 3	0.0082**	0.044	0.0091**	0.029	0.0095**	0.025	0.0009	0.298	0.0004	0.601	0.0003	0.685
NA level PR			-0.003***	0.002	-0.003***	0.004						
RN level PR			0.0013**	0.034								
PSP PR			0.0411**	0.035	0.0401**	0.036						
SSR PP									-0.037	0.044**	-0.042	0.036**
Size1 PP									-0.028	0.05**	-0.036	0.017**
OccRate 1 PP			-0.034**	0.045	-0.038**	0.031						

	Proportion of registered nurses						Change in the proportion of registered nurses					
	Eq. 9		Eq. 10		Eq. 11		Eq. 9		Eq. 10		Eq. 11	
	Est.	Pvalue	Est.	Pvalue	Est.	Pvalue	Est.	Pvalue	Est.	Pvalue	Est.	Pvalue
EQ 2 PP			-0.022**	0.028	-0.023**	0.024						

Source: SAE données administratives - ministère chargé de la santé, DREES, 2006-2008 and DADS, 2006-2008, INSEE

PR stands for private not for profit, PP stands for private for profit and PU stands for public. NA stands for nurse assistants and RN stands for registered nurses.