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Impact of private health insurance on a public healthcare system: the case of cesarean deliveries

Carine MILCENT[‡] and Saad ZBIRI[§]

Abstract

According to the health economics literature, medical practices respond to the source of hospital payments and the rules that govern them. Here, we study the impact of supplementary private health insurance within the DRG-based financing of French hospitals. We use differences between the public and private hospital sectors in managers' and doctors' incentives (in terms of potential additional payments) and examine their effect on the practice of cesarean deliveries. We mobilize exhaustive delivery data from a French district over a 7-year period (2008-2014) and consider factors that are known to influence obstetric practices. Our empirical results show that, although private hospitals are financed by a single public payer, like those in the public sector, they perform significantly more cesarean deliveries than public hospitals. This result is partially explained by additional payments covered by private health insurance and charged by private but not public hospitals.

JEL classification: I11, I13, I18

Keywords: Private health insurance; Public healthcare system; Activity-based payment; Cesarean delivery;

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1. Introduction

Activity-based payment using diagnosis-related groups (DRGs) is now used in most developed countries. All French hospitals, public and private, are publicly paid through a DRG-based¹ prospective payment system, introduced in 2008. Here, we investigate the impact of private health insurance on a hospital healthcare system where both public and private sectors are publicly, and apparently similarly, funded.

What we are looking at in this study is appropriateness of cesarean deliveries. Like previous papers on cost efficiency and hospital performance (Hafsteinsdottir and Siciliani, 2010), we examine the argument of efficiency. The literature, both theoretical and empirical, has examined the overall effect of activity-based payment. Although convincing theoretical arguments lead to expectations of hospital cost reductions and improved efficiency, the empirical evidence is inconclusive. The introduction of the DRG system was associated with positive effects on hospital efficiency in Finland (Linna, 1999), Portugal (Dismuke and Sena, 1999), Norway (Biørn *et al.*, 2003; Biørn *et al.*, 2010), and Switzerland (Widmer, 2015), while no such effects were found for Germany (Herwartz and Strumann, 2014), Italy (Barbetta *et al.*, 2007), Austria (Sommersguter-Reichmann, 2000), or the United States (Borden, 1988; Chern and Wan, 2000).

In public hospitals, France has a model where hospitals are in competition but physicians are salaried. In private hospitals, both hospitals and their physicians are paid according to their level of activity, but also receive additional payments from private health insurance. This raises the questions of doctors' profit-oriented practices. Baker *et al.* (2014) examined the consequences of contractual or ownership relations between hospitals and physician practices, often described as vertical integration. They found that "an increase in the market share of hospitals with the tightest vertically integrated relationship with physicians — ownership of physician's practices — is associated with higher hospital prices and spending." A systematic review examining the factors explaining the diversity of findings regarding hospital ownership and quality (Eggleston *et al.*, 2008) reports that the diverse results in the hospital ownership literature can largely be explained by differences in institutional context, including differences across regions and markets, and over time.

¹ A specific DRG classification was set up in France. For simplicity's sake, the term "DRG" will be used as a generic term that includes the French classification.

Most empirical work on the effect of reimbursement rules on healthcare production uses U.S. data (see Sloan, 2000, for a review). However, the structure of the U.S. healthcare market makes it hard to disentangle the pure effect of hospital ownership from other institutional features such as the segmentation of insurance or payers and payment types (Lien *et al.*, 2008). In France, the national health insurance system (*Sécurité Sociale*) is a single-payer system that covers the entire population. Studying the French context usefully eliminates any concern about, on the supply side, different reimbursement schemes for different payers, negotiation between providers and payers, and cost-shifting behavior by providers, and on the demand side, financial access to hospitals.

Controlling for relevant patient- and hospital-level characteristics, we find that private hospitals perform more cesarean deliveries than public-sector hospitals. This result is explained by the context. Both sectors are publicly funded, but in the private sector both institutions and doctors receive additional payment from private health insurance for charges that public hospitals are not allowed to bill.

In the following section, we briefly outline the factors that determine the use of cesarean deliveries and the characteristics of French hospitals providing obstetric services. The third section describes the data used for this study and offers some preliminary statistics. The econometric strategy is presented in the fourth section, and the results and robustness checks are reported in the fifth. In the sixth, we discuss the results and conclude.

2. Cesarean delivery and the French healthcare system

2.1. Use of cesarean deliveries

Cesarean delivery is one of the most common surgical operations around the world (Gibbons *et al.*, 2012). Epidemiologic studies show a negative association between cesarean rates and maternal, neonatal, and infant morbidity and mortality (Althabe *et al.*, 2006; Villar *et al.*, 2007). This type of delivery may provide psychological and social well-being (Mazzoni *et al.*, 2011). However, it can also cause significant and sometimes permanent complications, disability, or death (Hyde and Modi, 2012; Souza *et al.*, 2010). It is also associated with a higher cost (Allen *et al.*, 2005; Rogers *et al.*, 2017). It should thus be undertaken only when medically necessary. The research literature identifies many interrelated factors that influence

the number of cesarean deliveries. These are related to the characteristics of women, medical staff, and hospitals.

Women's characteristics explain cesarean deliveries in part. Older women and those having their first child have a higher probability of cesarean deliveries (Cleary R *et al.*, 1996; Ecker *et al.*, 2001). The presence of some medical risk factors for the woman and/or her fetus, which may arise from conditions that existed before pregnancy (e.g., chronic diseases), or develop during pregnancy (e.g., eclampsia), or labor (e.g., dystocia), are associated with more frequent cesarean births (Menacker *et al.*, 2006; Penn and Ghaem-Maghami, 2001). Further, women of lower socioeconomic status have a higher probability of cesarean delivery than their more socioeconomically advantaged counterparts, at least in high-income countries (Linton *et al.*, 2004; Milcent and Zbiri, 2018), the choice of the woman herself may also be a factor (Mazzoni *et al.*, 2011).

The apparent increased use of "defensive medicine" in obstetrics is likely to contribute to the increase in cesarean deliveries. Many studies find a positive correlation between higher cesarean rates and the increase in obstetricians' perceived risk of complaints and litigation (Fuglenes *et al.*, 2009) or in their malpractice insurance premiums (Dubay *et al.*, 1999; Yang *et al.*, 2009).

The time required for a cesarean is relatively stable while the time required for a vaginal delivery is unpredictable. Cesarean deliveries thus make it easier to manage medical equipment and facilities as well as physicians' time. Analyses show that the probability of a cesarean delivery increases sharply on Friday evenings and decreases during the weekend as physicians factor their time off into their medical practices (Brown, 1996; Fabbri, 2008).

Heterogeneity of delivery practices may also be explained in part by hospital characteristics. Studies report an increased likelihood of cesarean deliveries for highly-equipped hospitals (Le Ray *et al.*, 2006), as well as for teaching hospitals (Hammond, 2015). Hospital organization also plays a role: The probability of a cesarean delivery is lower in hospitals where obstetricians are more available (Yee *et al.*, 2017). The size of the maternity unit also affects the probability of cesarean delivery in various ways (Roman *et al.*, 2008; David *et al.*, 2001). Staff organization in hospitals also has an impact (Zbiri *et al.*, 2018).

Finally, reimbursement rules affect the cesarean delivery rate. Gruber and Owings (1996) report that, after a drop in the birth rate in some U.S. states, the number of cesarean deliveries increased. Gruber *et al.* (1999) show that a significant pay gap between a cesarean and a vaginal delivery accounts for half of the differences in practices in the U.S. Using the data from Gruber *et al.*, Grant (2009) confirms the effect of physicians' financial incentives on cesarean rates. In France, Milcent and Rochut (2009), using data from before implementation of the activity-based payment, show that private for-profit hospitals performed substantially more cesarean deliveries than public sector hospitals. This disparity was attributed to the difference in hospital payment systems. This context has changed: all French hospitals are now governed by the same reimbursement rules for all acute care stays, including for childbirth.

2.2. Hospital sector and obstetric care in France

In the French hospital healthcare system, there is a single payer: the national health insurance funds (*Sécurité Sociale*). The public system sets its own fee schedule. Computation of its fees include some costs, such as doctors' salaries, that are absent for the private sector.² As a result, there are two fee scales according to sector, presumably close to equivalent after the private obstetrician bills the patient separately for his or her services. Table 1 presents the fee as a function of the hospital sector, for the first and last years of the study period. We observe that the mean DRG fee for delivery is around 2,500 Euros. The fee is around 40% higher for a cesarean than a vaginal delivery, and the difference in their fees is quite similar regardless of sector. Hence, the same financial incentives govern the provision of childbirth services in both sectors.

On the patient side, all households are compulsorily enrolled in this public health insurance, which is financed by deductions (or for the self-employed, mandatory contributions) of a percentage of income. In-patient obstetric services (delivery) are reimbursed at 100% of the fee, regardless of hospital sector. For those few people not otherwise covered because no one in the household is working, a special fund of the public health insurance system ensures equivalent 100% coverage for childbirth. Therefore, the healthcare reimbursement for admittance in both public and private hospitals comes from this single public health insurer.

² In the public sector, the doctor's wages are based on the civil servant grid, while in the private sector, independent physicians work on a fee-for-service basis, charging their patients directly.

Nonetheless, the situation is somewhat more complex. Only in private hospitals, patients can be charged additional fees for: (1) room and board, and (2) physicians' fees. Private supplementary health insurance reimburses most of these additional fees, and 95% of the French population has such private insurance (Ministry of Health, 2016).

The room and board fees may be substantial in private hospitals. They are around 60 to 100 Euros for a one-night stay and may thus encourage medical practices that maximize length of stay. Cesareans require longer hospitalizations than vaginal deliveries. A private hospital thus has an additional incentive to perform more cesarean deliveries.

Hospital sector also affects physicians' income. In France, physicians including obstetricians can split time between activities in the private sector and activities in the public sector. In the public sector, hospitals compete both within and across sectors. On the other hand, medical staff and doctors are salaried. Their volume of work activity does not affect their income. As a result, the doctor's choice of procedure is not influenced by income considerations. The doctor is a brake on the push to volumes. In the private sector, physicians bill mainly on a fee-for-service basis. They receive their payment from the institution as well as from the woman herself *via* additional fees. For this payment, a requirement is the presence of the physician during the delivery process. The supplementary fees vary from 50 to 2,700 Euros, and average from 200 to 300 Euros for a vaginal delivery and from 500 to 600 Euros for a cesarean delivery. For anesthetists, it is about 200 Euros.³ As in the U.S., both the doctor and the hospital administration in the French private sector have incentives to increase the volume of cesareans.

Besides, in public hospitals, women cannot choose their physician. The woman is assigned to a hospital but not to one obstetrician. During her pregnancy, a woman may see different physicians or even only or mainly midwives for her prenatal care visits. In a private hospital, however, she chooses a specific obstetrician who generally sees her for all of her prenatal care and delivery. The patient-physician relationship is thus closer, which increases the likelihood that the obstetrician will satisfy the woman's requests for delivery. Moreover, their ability to control their schedule (and keep evenings and weekends free) provides further incentives for cesarean birth for obstetricians at private hospitals.

³ Unpublished mutual insurance data from 2011, the only known reference in France.

Obstetricians are also more likely to practice defensive medicine, and cesarean deliveries may reduce malpractice liability because they reduce the risk of complications during delivery. More important, physicians at public hospitals are covered by the hospitals' malpractice liability insurance, while independent physicians in private hospitals must purchase their own malpractice insurance that is about 30,000 Euros per year for a full-time private sector activity's physician. This may be an incentive to perform more planned cesarean deliveries, in which the medical risk is lowest, and during a labor's complication, they are incited to turn on a cesarean act.

3. Data and preliminary statistics

We use exclusive French data that allow us to consider the factors that influence cesarean deliveries, including *i)* the woman's age and medical risk factors, *ii)* her household's socioeconomic situation, *iii)* hospital characteristics, including sector and the organization of the maternity unit.

3.1. Exhaustive delivery data

We mobilize data from deliveries in 2008 through 2014 from two databases. One database contains all deliveries in the Yvelines administrative district. The second database contains information about all French hospitals.

The first database comes from the first health certificate (*Premier Certificat de Santé*, PCS) of infants born in the district. In France, the PCS certificate is completed for each newborn before discharge from the maternity unit. In the Yvelines, it is supplemented by additional data concerning topics such as household deprivation, severe morbidity, and delivery trauma. The PCS database contains demographic information about the woman: age and parity;⁴ detailed information about her individual socioeconomic level and that of her partner: status of the couple, level of education, occupation, employment/labor force status, and location; information about the pregnancy: medical follow-up, hospital stays; information about the delivery: hospital, date, mode of delivery, and delivery procedures performed; and full information about maternal, fetal, and neonatal health: diagnoses and co-morbidities. The study includes all births in the Yvelines district during the complete calendar years from 2008 through 2014, but excludes deliveries that are stillbirths, medically indicated terminations of

⁴ Here, parity is the number of previous deliveries; nulliparous women are having their first child.

pregnancies, and births that occurred outside maternity units. The study sample thus comprises 102,236 deliveries, for 58,645 of which full socioeconomic data are available. Because this information on socioeconomic characteristics is quite important, we analyze all observations with complete socioeconomic data. However, as a robustness check, we also re-estimated all our results with the full sample of all observations.⁵ We find similar results which rules out the suspicion of omitted observations effect. The PCS database is processed by the general council of Yvelines (*Conseil départemental des Yvelines*), in collaboration with the regional public health administration agency (*Agence Régionale de Santé de l'Île-de-France*), and the local perinatal network (*Réseau Périnatal Maternités en Yvelines et Périnatalité Active*, MYPA). All data used are reported to the French data protection authority (*Commission Nationale de l'Informatique et des Libertés*, CNIL, number 1295794). The PCS certificate is completed, almost prospectively from birth, by midwives and physicians. The contents of the certificates are also double-checked to correct inaccurate and missing information. The information extracted is thus of high quality.

The second database is the French annual statistics for hospitals (*Statistique Annuelle des Etablissements de santé*, SAE). This survey, conducted by the Ministry of Health, provides information on all hospitals including their status, equipment level, volume of activity, medical staff composition, and location. The information on hospitals with obstetric care in the Yvelines district was located, checked, and supplemented through data from the local perinatal network.

3.2. Descriptive statistics

3.2.1. The French district of Yvelines

Yvelines is the eighth largest administrative district in France by population (French national institute of statistics (*Institut National de la Statistique et des Etudes Economiques*, INSEE), 2008-2014 data). Table A1 presents the summary statistics for patient- and hospital-level characteristics of the women giving birth in the district in 2008-2014. Their mean age is 30.7 years, and 43.1% of them are nulliparous. The most frequent medical risk factors for cesarean

⁵ See more details on the robustness checks in Section 5.4.

delivery are induced labor, previous cesarean, and other obstetric pathology,⁶ which account, respectively, for 21.6%, 10.3%, and 7.1% of all women.

The Yvelines district has some geographic disparities in its socioeconomic status. The eastern Yvelines is made up of middle-class and upper-class areas. The rest is composed of an extensive rural zone with sparsely distributed, high-income areas, and some quite low-income areas (INSEE, 2008-2014 data). In the model, we control for the rural/urban location of residents as well as the level of education and the type of occupation.

All hospitals are located in an urban area: There are hospitals (public as private) in well-off areas and hospitals are in poor areas as a private hospital in a municipality with an income's median of 16,000 Euros per year (compared to 20,000 Euros in the whole France territory (INSEE, 2008-2014 data)). As Table A1 shows, few women have no partner (2%). The majority of women (61.4%) have a post-secondary education.⁷ Most women and their partners work, 69.6% and 89.8%, respectively, versus 6.7% and 4.4% who are unemployed, and 23.7% and 5.8% who are not in the labor force.⁸ Differences also exist in occupations. Both the women and their partners work most often in office, sales, and service occupations, respectively 55.2% and 40.1%, and in second place, as managers and in higher intellectual occupations, respectively 31% and 36.7%.

The Yvelines administrative district is well served by healthcare facilities providing obstetric care. There are 11 hospitals with 5 public hospitals and 6 private hospitals. All private hospitals in the Yvelines are private for-profit hospitals. From 2008 through 2014, the number of deliveries is stable and it accounts for 13% of the annual number of deliveries on the whole France territory (SAE, 2008-2014 data). In this district, 66.4% of deliveries take place in public hospitals and 33.6% in private hospitals. The distribution of births by sector is similar to the nationwide distribution.⁹ Maternity units without special neonatal care (equipment level 1, with the least equipment) account for 19.1% of deliveries, versus 39.6% and 41.3%,

⁶ The "other obstetric pathology" variable includes the diagnoses and co-morbidities not already considered individually (previous cesarean, diabetes, hypertension, eclampsia, and preeclampsia, intrauterine growth restriction, and placental disorder are all individual variables), that is, for example, infection, premature rupture of membranes, obesity, or amniotic fluid abnormality.

⁷ In contrast to those with some secondary school, women who completed secondary education have reached the final year of secondary school, whether or not they obtained the baccalaureate degree.

⁸ Those not in the labor force include students, apprentices, homemakers, retirees, those on parental leave, and others neither working nor looking for work.

⁹ In France, 66% and 34% of the deliveries were performed in public and private hospitals, respectively (SAE, 2008-2014 data).

respectively, for hospitals with special and intensive neonatal care units. Moreover, university hospitals perform 37.5% of the deliveries in the district.

The Yvelines district has an average cesarean rate of 23.9% for the study period, higher than the national rate of 20.3% during the same period (SAE, 2008-2014 data). The Yvelines cesarean rate is lower in the public (22.3%) than in the private sector (27.2%). From 2008 to 2014, the overall rate is relatively stable. However, it decreases in public hospitals by 9.3% while it increases by 13.9% in private hospitals.

3.2.2. Public versus private hospitals

Population characteristics vary notably by hospital sector (Table A1). Women giving birth in private hospitals are older than those in public hospitals, 31.5 years versus 30.3 years. Nonetheless, public hospitals provide care for a population considered to be at higher risk than those in private hospitals. For example, 4.3% of women giving birth in public hospitals have diabetes versus 3.3% of those admitted to private hospitals.

Similarly, the economic level of households affects the sector: the percentages of low-educated, low-skilled, and non-working women are all higher in public than in private hospitals, respectively, 42.8% versus 30.5%, 60.4% versus 49.3%, and 32.8% versus 25.5%. The same disparities appear for the partners: in public hospitals, 55.7% and 11.7% of parturients' partners are, respectively, low-skilled and not working, compared with 39.3% and 11.7%, in private hospitals.

Comparing equipment level by sector, we observe that the majority of births in public hospitals take place in high-equipped maternity units with neonatal intensive care (62.2%), while in private hospitals women most often give birth in maternity units with special neonatal care (60%). Note that all hospitals with neonatal intensive care and all those that are teaching hospitals are public.¹⁰

Finally, focusing on organizational factors, we see that public hospitals have a higher rate of births on non-working days including weekends and holidays than private hospitals, 27.9% versus 23.5%.

¹⁰ In France, the hospitals with neonatal intensive care unit are all in the public sector. Moreover, any institution with an intensive care unit would be required to accept emergency cases, which might explain the absence of any private neonatal intensive care unit.

4. Econometric strategy

The empirical analysis uses panel data to assess the effect of the hospital sector on the practice of cesarean deliveries.

A simplified way of writing the basic model we set up is as follows:

$$P(Y) = f(T, D, X, S, W, V, I, e)$$

with Y equal to 1 if woman i in hospital j in year t has a cesarean.

- T_t is a linear continuous time variable (trend), starting in 2008 (trend=0) and ending in 2014 (trend=6);

- D_{ijt} is the set of variables of demographic characteristics for patient i in hospital j in year t : age and parity;

- X_{ijt} is the set of medical risk factors of woman i in hospital j in year t such that one of them justifies or favors performing a cesarean delivery: previous cesarean, diabetes, hypertension, eclampsia or preeclampsia (including HELLP syndrome), intrauterine growth restriction, placental disorder (including placenta previa, placenta accreta, and abruptio placenta), other obstetric pathology (such as obesity, infection, premature rupture of membranes, amniotic fluid abnormality, or congenital anomaly), multiple pregnancy, preterm delivery (gestational age < 37 weeks), post-term delivery (gestational age > 41 weeks), fetal breech presentation or transverse lie, induced labor, low birth weight (< 2500 grams), and high birth weight (> 4000 grams);

- S_{ijt} is the set of variables for socioeconomic characteristics for patient i in hospital j in year t : status of the couple, level of education, type of occupation, and work status of the woman, and her partner's type of occupation and work status, and rural woman's location;

- W_{jt} is the set of hospital type variables for hospital j in year t : sector, equipment level, and university status;

- V_{ijt} is the set of variables concerning hospital organization: the 24-hour availability of obstetricians for hospital j in year t , the day of delivery for woman i in hospital j in year t , the size of the unit based on the volume of deliveries of hospital j in year t , and the numbers of

midwives, of obstetricians, and of anesthetists working at hospital j in year t , as measured by full-time equivalent (FTE) employees per occupied patient bed;¹¹

- I_{ijt} is a vector of the dummy variables for a private supplementary insurance covering additional payment for obstetric acts contracted by the woman i in hospital j in year t . We do not have the individual information on the private supplementary insurance coverage. We then use the macro information as given by the Ministry of Health and based on the employment status. For each status of employment, we use the weighting set up by the Ministry of Health. The high coverage is defined as a weighting of private health insurance higher or equal to 0.9 and inversely the low coverage for a weighting of private health insurance lower than 0.9 (Table 2). When the woman is less covered by her private insurance than her partner, she can be the beneficiary of her partner. Therefore, the private insurance coverage of her partner is also considered. We therefore have 4 dummy variables including the 4 possible situations of coverage by private supplementary insurance: a high probability of coverage for the woman and for her partner, a low probability of coverage for the woman and her partner, a high probability of coverage for the woman and a low probability for her partner, and the reverse situation, a low probability of coverage for the woman and a high for her partner.

- e_{ijt} is the error term.

[Insert Table 2]

We use hierarchical data: patients grouped by their hospitals. We estimate multilevel logit models with the robust variance that takes the lack of independence between observations at the hospital level into account. The Hausman specification test between the specifications of the hospital fixed-effects and the hospital random-effects results in accepting the null hypothesis (p-value > 0.10). The hospital random-effects model thus produces consistent and

¹¹ The amount of time independent private practitioners spend on their hospital practice is not known. As a result, we suggest that part-time private practice doctors work 50% of the time at the hospital, and thus represent 50% of a FTE. This standard assumption is widely used (Clark and Milcent, 2011; Zbiri *et al.*, 2018). While this is perhaps reasonable, we also check that all our results are robust to the more extreme assumptions of 25% and 75% of a FTE (see Section 5.4).

efficient estimations: The hospital's characteristics not explicitly taken into account in the model are not correlated with any independent variables.¹²

We face a main estimation issue. The heterogeneity in preference is likely to affect the delivery act. As illustrated by Figure 1a, the intention-to-treat (ITT) depends on woman's preference and physician's preference that itself depends on woman's clinical aspects, physician's practice characteristics, risk's aversion for malpractice, and financial incentives. Woman's clinical aspects are related to physician's practice characteristics and his risk aversion for avoidable complications (malpractice). Financial incentives depend on the Health Authorities reimbursement scheme that is equivalent for the public sector and the private sector. Besides, for private sector only, it depends on the supplementary insurance contract of the woman or her partner that may reimburse the additional payment (at least partially). Private supplementary insurance makes affordable an act by cesarean in reimbursing the additional payment in hospitals of the private sector. Woman's preference also impacts the physician's ITT. The main channel for woman to express her preference in delivery's mode is the effect on the demand that is only true for the private sector. This demand is related to the supplementary private health insurance coverage that makes affordable the additional payment for cesarean act. As a consequence, the act's choice is only partially impacted by the woman's clinical aspects. For women with low clinical risk, the ITT by planned cesarean is more strongly associated to the private insurance than the ITT by unplanned delivery.

[Insert Figure 1a]

In this paper, we identify the supplementary insurance as an actor of the process of the treatment's decision. To do so, we sequentially eliminate the non-financial incentive factors influencing the act performed by reducing the sample *i*) to the low clinical risk women¹³ and *ii*) to focus on the planned cesarean act (Figure 1b). As a result, the differences between sectors is attributed to financial incentives. A private supplementary insurance dummy measures the woman's affordability for cesarean in the private sector. It measures the impact of the private insurance on the act's decision.

[Insert Figure 1b]

¹² We also use the hospital fixed-effects model as a robustness check. See more details in Section 5.4.

¹³ The definition of the low risk subsample is based on the usual obstetrical literature (Coulm *et al.*, 2012).

5. Results

5.1. Patient and hospital factors

Table A2 in the Appendix reports the effects of the individual and hospital control variables on the probability of cesarean deliveries. Among the demographic characteristics, as expected, age and nulliparity increase this probability. Also as expected, well-known obstetric risk factors affect mode of delivery. Cesarean delivery is most prevalent for at-risk patients compared with those women who are at low risk. A non-vertex fetal presentation or transverse lie, previous cesarean, and placental disorder are the strongest risk factors.

Socioeconomic characteristics that increase a woman's probability of cesarean birth include no postsecondary education, compared to more highly educated women. Similarly, women in low-skill jobs, such as manual workers, or office, sales, and service workers, or a middle-skill job, such as workers with intermediate occupations, are more likely to have a cesarean delivery than those with high-skill jobs, for instance, managerial or higher intellectual professionals. If the woman is unemployed, her probability of a cesarean delivery increases. Moreover, women not living with a partner are less likely to have a cesarean than women with a partner. The same is true for the partner's socioeconomic characteristics: low-skill occupations increase the probability of cesarean delivery, compared to high-skill professional positions. Accordingly, the probability of cesarean is higher for women whose partners are not in the labor force, compared with those who work. Besides, we control for rural versus urban location in column 2 of Table A2. Women living in rural areas have less probability of a cesarean than those living in urban areas at 9% significance level. In the following regression models, we suppress this variable because of the number of missing values (11.5%). Note that including this variable does not change the following results (available upon request).

Hospital factors checked as control variables include neonatal equipment level; maternity units with neonatal care, versus those with no special neonatal care, have an increased probability of cesareans. Giving birth on a non-working day is negatively associated with cesarean delivery. Since many cesareans can be planned ahead, surgical deliveries are more

likely to take place on working days.¹⁴ Study of medical staffing levels shows that the more obstetricians per patient bed, the less likely a delivery by cesarean.

In summary, different individual and institutional characteristics are significant indicators of cesarean deliveries. Our results are in accordance with the findings from the literature.¹⁵

Moreover, we tested for a linear time trend for the seven-year period to identify any patterns of incidence for cesarean deliveries over the 2008-2014 period. Taking into account all the factors, we observe a non-significant global trend.

Table 3 presents the effects of hospital sector on women's probability of cesarean delivery. Column 1 of Table 3 shows that, after controlling for age, parity, and medical risk factors, admission to a private, compared with public, hospital increases the probability of cesarean delivery. Next, in addition to these epidemiologic factors, we consider socioeconomic factors in column 2 and find that private hospitals still have a higher rate of cesarean deliveries. In column 3, we also control for the hospital's type and organization and show that, all else being equal, giving birth in a private hospital substantially increases the probability of cesarean delivery. Computing the odds ratio, we find that the probability of cesarean delivery rises by 79% in a private versus a public hospital (odds ratio = 1.79, 95%CI = [1.29-2.49]).¹⁶ However, this hospital sector effect may capture other determinants as described above.

[Insert Table 3]

5.2. Impact of financial incentives

A cesarean birth may cause increased and perhaps unnecessary morbidity to a woman, as it is major surgery. However, obstetricians may be protecting themselves from malpractice litigation. When a woman has a medical risk factor, a cesarean can be a defensive act to prevent complications during delivery. The physician's practice characteristics leading to perform cesarean versus complicated vaginal delivery are on stake. Some physicians are particularly good to perform a cesarean with very low medical mark and others are specifically qualified to perform a complicated and hazardous vaginal delivery. Therefore,

¹⁴ When we focus only on unplanned deliveries, the effect of delivering on a non-working day is no longer significant. Results are available upon request.

¹⁵ As shown above in more details in Section 2.1.

¹⁶ The previous literature shows similar private/public hospital differences in magnitude (Lutomski *et al.*, 2014; Salvador *et al.*, 2009).

physician's practice characteristics and defensive medicine cannot be disentangled. This question of defensive medicine choice as well as physician's practice characteristics does not come into play for women at low risk, or very marginally. When we compute the effect of hospital sector on the cesarean rate using each of the two subsamples thus defined and compare the results, we capture behavior due to self-protection against malpractice liability. Table 4 presents the sector effect on the use of cesarean deliveries for both the high and low medical risk subgroups, in columns 1 and 3, respectively. The high medical risk subgroup includes all women with at least one medical risk factor while the low medical risk subgroup only includes women without any medical risk factor. This low risk set of variables mixes clinical risk factors during the pregnancy and clinical risk factors during the delivery process. Regardless of other observed factors and of woman's degree of risk, private hospitals perform more cesarean deliveries than public hospitals do. According to Figure 1b, for women with low clinical risk, here, we capture woman's preference and physician's financial incentive that are only present in the private sector. This finding confirms that the additional fees in the private sector (based on the additional room and board payment and the physicians' additional fees) associated with woman's preference plays on the disparity we observe in the mode of delivery between the two sectors.

Actually, in the subsamples considered here, the treatment is the result of two different intention-to-treats (Figure 1a): by planned cesarean or unplanned delivery. As previously explained, the physician is less respondent to the financial incentive when his ITT is unplanned delivery. Indeed, the additional payment implies the presence of the physician during the delivery process that is only guaranteed with a planned cesarean. Moreover, they may have some unobserved factors (by the econometrician) popping up during the unplanned delivery process (extreme stress of the woman, operating staff not straight away available ...) that play in the decision to perform a cesarean as an emergency act. As a consequence, we now focus on ITT by planned cesarean.

The ITT is probably influenced by sector's differences. In private hospitals, a woman chooses her own obstetrician, who will provide her prenatal care and be present for her child's birth. The relationship between the patient and the obstetrician is accordingly closer than in a public hospital where women do not see the same physician continuously throughout pregnancy. We assume that if the woman has a preference for a cesarean delivery, the obstetrician will plan

it,¹⁷ and the woman will be ready to pay for it. Indeed, in this planned cesarean context, the woman knows in advance that the delivery act in a for-profit hospital implies additional payment and the amount of the out-of-pocket based on her supplementary insurance package. On the other hand, the obstetrician may prefer a cesarean rather than a normal delivery based on factors as given in Figure 1a. Their close relationship with their patients may allow them to convince these women. The financial incentive is then very strong because it is based on the combination (women's preference, physician's preference). This combination can be expressed all the more so as the supplementary insurance package is advantageous. We then assess the impact of the supplementary insurance for hospitals in the private sector. In order to rule out the clinical risk determinants, we restrict the sample to the women with low clinical risk.

After adjusting for all variables including epidemiologic, socioeconomic, institutional, and organizational factors, we find that the hospital sector remains an independent factor for cesarean delivery (column 1 of Table 5).

These results highlight the financial incentive impact on the delivery act performed. Whatever the private insurance package, we show an effect of hospital sector on cesarean deliveries. This finding shows that, besides the effect of the other potential factors, the compensation scheme matters strongly in procedure choice.

What about the unplanned cesarean delivery? Theoretically, a weak effect of the financial incentive is expected. Indeed, the ITT was to go to unplanned delivery. Then, the physician is not certain of his presence at the date of the delivery that is conditional to the additional payment. As before, we then restrict the sample to the women with low clinical risk i.e. women for whom defensive medicine is a marginal factor and we suppress the planned cesarean cases. Therefore, we focus on the urgent cesareans and we render marginal the clinical reasons of urgent cesareans. Holding all other covariates constant, we find a significant hospital sector effect (Column 3 of Table 5). However, this sector impact is much lower than the one found for planned cesarean deliveries as theoretically expected: for the unplanned cesareans and women with low medical risk, the odds ratio of the sector variable is 1.61 (95%CI = [1.37-1.90]) whereas for planned cesareans group, the odd ratio is of 4.86 (95%CI = [2.77-8.51]).

¹⁷ The data available here do not allow us to know the woman's preference. This assumption seems reasonable to us.

Here, there is no reason to believe that the obstetrician is present at the cesarean delivery moment. We thus cannot interpret the difference in the mode of delivery between the public sector and the private sector only as a financial incentive impact of the physicians. It can be organizational factors regarding emergency situations. For instance, the nighttime, the medical staff may be not enough for dealing with popping up unexpected factors unobserved by the econometrician.

As a general result, there is no overall effect of the private insurance. The only effect is through the admittance in hospitals of the private sector. This result emphasizes the link between private insurance and private sector in terms of accessibility for women and financial incentive for private providers (Tables 4 and 5).

5.3. Supplementary private health insurance

Having shown the financial incentive impact, we now turn on the woman's affordability impact on this financial incentive.

If the underlying explanation for the higher rate of cesarean deliveries in private compared with public hospitals is partially due to private supplementary health insurance, this higher rate should differ according to the private insurance status of the woman. Focusing on the effects of the private insurance coverage in the private sector on cesarean delivery for low clinical risk women, we show that the level of coverage impacts the cesarean rate (Table 4). Indeed, in term of supplementary private insurance, comparing the coefficient estimates between women with a high coverage and those with a low coverage, we find a significant difference at the level of 9% (column 4 of Table 4, Chi-square test = 2.78, p-value = 0.09). As a result, the more probability of private insurance coverage, the more probability of cesarean. On contrary, when we focus on the subsample of women with high clinical risk, we observe no difference in the probability of having a cesarean between women with a higher versus a lower probability of private supplementary insurance (column 2 of Table 4, Chi-square test = 1.53, p-value = 0.22).

As a result, for woman without clinical risk factors, private supplementary health insurance impacts the probability to be delivered by cesarean. We find that the probability of cesarean delivery for woman with low clinical risk rises by 98% for those with a higher probability of

supplementary insurance in a private hospital compared to those with a supplementary insurance in a public hospital (odds ratio = 1.98, 95%CI = [1.48-2.61]).

However, we may argue that the significant level of the private supplementary health insurance effect is high for the two sub-groups. As said below, this sample deals with two ITTs that may impact the result.

[Insert Table 4]

ITT planned cesarean delivery

For women without a supplementary insurance contract, the impact of hospital sector is significantly much lower than for those with a supplementary insurance contract at 5% significance level (column 2 of Table 5, Chi-square test = 4.06, p-value = 0.04). That is, at the significant level of 5%, compared with women or their partner having a high probability of private supplementary insurance (odds ratio from 4.18 to 4.79, 95%CI from 1.91 to 10.78), there is a gap in the difference in the cesarean rates ~~between sectors~~ for women who barely can afford to pay for a cesarean delivery and lack insurance for it - and only for them (odds ratio = 2.33, 95%CI = [0.94-5.79]) (see columns 2 and 3 of Table 5).

ITT unplanned delivery

We explore the effect of the woman's affordability on the financial incentive by assessing the impact of the supplementary insurance for hospitals in private sector (Column 4 of Table 5). We observe no difference in the probability of having a cesarean between women with a higher versus a lower probability of private supplementary insurance (Chi-square test = 0.20, p-value = 0.66). We conclude that the woman's preference at the heat of the moment that may affect the decision is independent of any private insurance coverage reasons. As well, physician's preference does not depend on the woman's private insurance coverage.

[Insert Table 5]

5.4. Robustness checks

In this paper, we control for unobservable hospital heterogeneity by using hospital random-effects. As previously explained, the Hausman test validated this econometric approach. As a sensitivity analysis, we look for the sector's effect (variable of interest) when using a hospital

fixed-effects. A strict collinearity exists between the hospital fixed-effects and the invariant explanatory variables at the hospital level. We therefore use a two-step fixed-effects model. Clustered standard errors of the second stage are estimated by bootstrap due to the use of an estimated dependent variable. The results using the hospital fixed-effects specification are very similar to the previous findings based on hospital random-effects specification (Table A3).

Second, our dataset covers the entire population of women who gave birth in the Yvelines over the period of 2008-2014. Because household socioeconomic information is not available for all observations, the analyses we present use all observations with complete socioeconomic data that enable us to control for all socioeconomic characteristics. To verify the lack of bias of this sample, we re-estimate all the models by using the full set of observations without taking socioeconomic information into account. The results, using hospital random- or fixed-effects, are similar to those based on our main sample (Table A4). The descriptive analysis further supports this finding that the distribution for the variables in the whole population and the main sample of analysis are almost identical.

Third, we may argue that to assess the financial incentive impact, we may compare the planned cesareans with the normal deliveries, suppressing the urgent cesareans. Doing so implies to introduce a bias in the results. Indeed, any urgent cesarean can be an obstetrician's decision based on financial incentives or on a popping up unexpected factor unobserved by the econometrician. As a robustness test, we run the model on the subsample including planned cesareans and normal deliveries. Results are presented in Table A5. As can be checked, the results are on the same line.

Fourth, the cut-off of the definition of the high probability of private health insurance used (0.9) is arbitrary. However, we run the models with cut-offs of 0.85, of 0.80, and of 0.75. The results are unchanged (available upon request). One limit of this paper is that we do not have the individual information on the private health insurance coverage. Since the French organization of the health insurance market is highly connected with the professional status, we believe that the medical staff assumes that the woman is covered by a supplementary private health insurance (overall, 95% of the population is covered by a supplementary private insurance). The supplier's behavior is driven by the financial incentive. In this paper, we underestimate the percent of woman having a supplementary private health insurance. A private insurance coverage is the standard case for 95% of the population and a no private

insurance coverage is the exception. As a result, we underestimate the effect of the supplementary private health insurance effect on the financial incentive impact.

Lastly, to treat the heterogeneity between public and private hospitals concerning information about hospital staff, we consider an average situation in which independent physicians working part-time devote 50% of their time to their hospital work. To verify that this hypothetical weighting does not affect our results, we test two extreme cases: a so-called minimal level of work in which they devote only 25% of their time to the hospital and a so-called maximal level of work, obtained by applying a coefficient of 0.75 to the total. These 25% and 75% extreme weightings for hospital work time of private physicians produce results similar to those based on the average weighting (Full tables of results are upon request).

6. Conclusion

As a conclusion, the additional fees in the private sector are a real financial incentive to perform planned cesarean deliveries and may therefore explain part of the disparity we observe in the mode of delivery between the two sectors.

Different characteristics of the healthcare market may drive costly health behaviors. One of them is the hospitals' mode of financing. Payments to hospitals may result in financial incentives that may encourage healthcare providers, including hospitals and the physicians they employ, to perform some medical interventions rather than others. Most developed countries have recently adopted activity-based payment systems for the purpose of improving hospital efficiency as well as the quality and effectiveness of care. However, empirical evidence is scarce, except from the U.S.

Cesarean deliveries are among the most common surgical procedures and absorb large quantities of healthcare resources annually. They are also one of the medical practices studied most by economists because they are potentially responsive to a variety of economic forces including source of payment and financial incentives.

This study used previously unexplored delivery data from a French district to examine the effect of hospital sector — private versus public — on utilization of cesarean deliveries, in the context of a unique single-payer healthcare finance system. The empirical analysis reveals

that, after controlling for a large number of determinants for individual- and hospital-level factors that may affect obstetric practices, the probability of a cesarean birth is higher in a private than a public hospital.

Despite the apparent similarity of funding for the private and public hospital sectors under a unique payment system, private hospitals receive an additional payment from their patients for room and board, costs which are not reimbursed by the single-payer public health insurance. The fees are, however, covered by private supplementary health insurers that help make care affordable for all patients regardless of whether it is public or private, and whether the delivery is cesarean or vaginal. As a result, women's preference for the mode of delivery act is not restrained by financial accessibility. But private supplementary health insurers disturb the public regulation set up by the reimbursement system of the single-payer public health insurance system. Specifically, the private health insurance affects medical practices in a market-driven public healthcare delivery system, including by creating incentives for harmful practices. These private health insurance policies and choices may affect or prevent the implementation of public policies developed by policy makers for the welfare of the society.

This result may be applicable abroad to other healthcare systems, for instance, the development of private medical insurance in addition to the National Health Service and Medigap policies in addition to classic Medicare. These forms of public healthcare funding, whether they are intended for all (France, U.K.) or for some (Medicare in the U.S.), have been set up with the objective of addressing inequity in access to healthcare. However, the development of the portion of medical care supported by supplementary private health insurance may impair this social goal of equity.

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Figures

Figure 1a. Identification process from the intention-to-treat to the delivery act

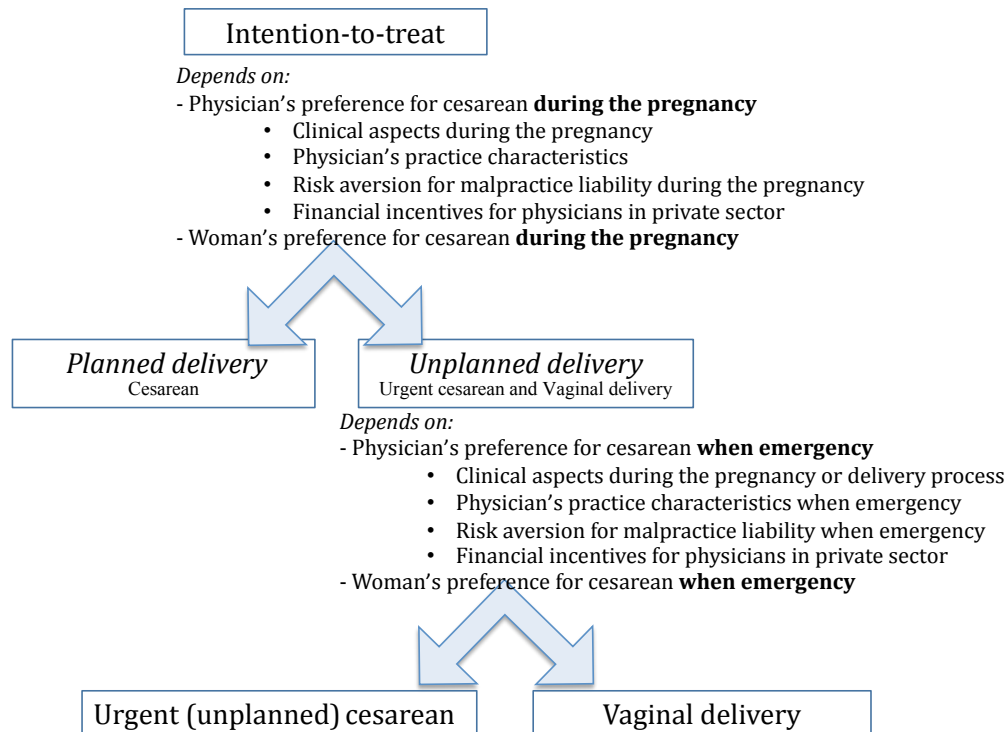
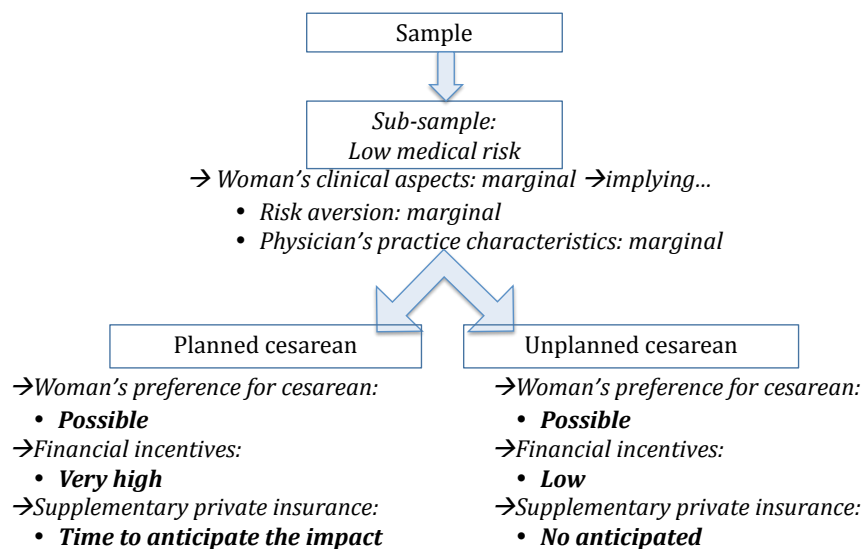


Figure 1b. Identification process of the financial incentives on the intention-to-treat by (un)planned cesarean act



Tables

Table 1. DRG fees for stays including childbirth by hospital sector.

	2008		2014	
	Public	Private	Public	Private
No complication				
Vaginal delivery (Euros)	2,164	1,450	2,439/2,054	1,490/1,282
Cesarean delivery (Euros)	2,983	1,789	2,812	1,759
Difference (%)	+38%	+23%	+15%/+36 %	+15%/+37%
Minor complication				
Vaginal delivery (Euros)	2,615	1,631	2,900/2,336	1,669/1,435
Cesarean delivery (Euros)	4,208	2,202	4,153	2,891
Difference (%)	+61%	+35%	+43%/+77%	+73%/+101%
Major complication				
Vaginal delivery (Euros)	3,347	1,803	3,071/2,615	1,803/1,617
Cesarean delivery (Euros)	4,900	2,346	4,383	2,967
Difference (%)	+46%	+30%	+43%/+67%	+65%/+83%

Note: Stays presented are those for singleton deliveries. For 2014, fees vary between nulliparous and multiparous women who deliver vaginally and are reported in that order.

Data source: French technical agency for hospital information (the *Agence Technique de l'Information sur l'Hospitalisation*, ATIH), 2008-2014.

Table 2. Rates of coverage by supplementary private insurance according to the employment status.

	Overall rate	Rate excluding CMU-C
<u>High coverage</u>		
Working people (including those on parental leave)	96%	94%
Retirees	95%	94%
Students and apprentices	95%	92%
<u>Low coverage</u>		
Homemakers	91%	71%
Unemployed people	86%	61%
Other people neither working nor looking for work	86%	73%

Note: For the poorest, they can be covered by a public supplementary insurance playing an equivalent role as a private supplementary insurance, named CMU-C. However, this public supplementary insurance does not cover extra-cost defined here for cesarean in a private hospital. Therefore, we use the coverage's rate excluding CMU-C to create the private supplementary insurance variable (I_{ijt}).

Data source: French Ministry of Health (the *Ministère de la Santé*, DREES), 2012.

Table 3. Effects of hospital sector on cesarean deliveries. Multilevel logit models (coefficient estimates).

	1	2	3
Time			
Trend	0.003 (0.014)	0.002 (0.015)	0.001 (0.013)
Hospital sector			
Private	0.418*** (0.117)	0.460*** (0.120)	0.582*** (0.168)
Demographic control variables	Yes	Yes	Yes
Medical control variables	Yes	Yes	Yes
Socioeconomic control variables	No	Yes	Yes
Hospital control variables	No	No	Yes
Observations (<i>N</i>)	58,645	58,645	58,645

Note: Robust standard errors clustered at the hospital level in parentheses. *** = 1% significance level, ** = 5%, * = 10%. All regressions use the main sample with complete socioeconomic data. Control variables include for demographics: age and parity; for medical risk factors: previous cesarean, diabetes, hypertension, eclampsia or preeclampsia, fetal growth restriction, placental disorder, other obstetric pathology, plurality, term at delivery, fetal presentation, induced labor, and birth weight; for socioeconomic status: woman's status of the couple, education, occupation, and work status, and her partner's occupation and work status; and for hospital characteristics: equipment level, teaching status, obstetrician availability, day of delivery, size, and numbers of full-time midwives, obstetricians, and anesthetists per occupied bed.
Data source: PCS, SAE, Yvelines district (France), 2008-2014.

Table 4. Effects of hospital sector on cesarean deliveries, for different medical severity subgroups. Multilevel logit models (coefficient estimates).

	High medical risk		Low medical risk	
	1	2	3	4
Time				
Trend	-0.001 (0.016)	-0.001 (0.016)	0.006 (0.012)	0.006 (0.012)
Hospital sector				
Private	0.633*** (0.167)		0.677*** (0.145)	
Supplementary private health insurance				
High coverage (woman and her partner)		Reference		Reference
High coverage (woman) and low coverage (partner)		0.123* (0.072)		-0.352 (0.409)
Low coverage (woman) and high coverage (partner)		-0.077 (0.063)		0.094 (0.154)
Low coverage (woman and her partner)		0.018 (0.175)		-0.143 (0.199)
Crossed variables for hospital sector and supplementary private health insurance				
Private x High coverage (woman and her partner)		0.615*** (0.170)		0.683*** (0.149)
Private x High coverage (woman) and low coverage (partner)		0.593** (0.254)		0.613* (0.325)
Private x Low coverage (woman) and high coverage (partner)		0.754*** (0.170)		0.657*** (0.169)
Private x Low coverage (woman and her partner)		1.080** (0.430)		0.505** (0.200)
Demographic control variables	Yes	Yes	Yes	Yes
Medical control variables	Yes	Yes	Yes	Yes
Socioeconomic control variables	Yes	Yes	Yes	Yes
Hospital control variables	Yes	Yes	Yes	Yes
Observations (<i>N</i>)	28,312	28,312	30,333	30,333

Note: Robust standard errors clustered at the hospital level in parentheses. *** = 1% significance level, ** = 5%, * = 10%. All regressions use the main sample with complete socioeconomic data. Control variables include for demographics: age and parity; for medical risk factors: previous cesarean, diabetes, hypertension, eclampsia or preeclampsia, fetal growth restriction, placental disorder, other obstetric pathology, plurality, term at delivery, fetal presentation, induced labor, and birth weight; for socioeconomic status: woman's status of the couple, education, occupation, and work status, and her partner's occupation and work status; and for hospital characteristics: equipment level, teaching status, obstetrician availability, day of delivery, size, and numbers of full-time midwives, obstetricians, and anesthetists per occupied bed.
Data source: PCS, SAE, Yvelines district (France), 2008-2014.

Table 5. Effects of hospital sector on cesarean deliveries, for (un)planned cesareans. Multilevel logit models (coefficient estimates).

	Planned cesareans for low medical risk		Unplanned cesareans for low medical risk	
	1	2	3	4
Time				
Trend	0.041** (0.019)	0.041** (0.019)	-0.011 (0.013)	-0.011 (0.013)
Hospital sector				
Private	1.547*** (0.284)		0.477*** (0.084)	
Supplementary private health insurance				
High coverage (woman and her partner)		Reference		Reference
High coverage (woman) and low coverage (partner)		-0.758 (0.527)		-0.220 (0.414)
Low coverage (woman) and high coverage (partner)		-0.013 (0.143)		0.190 (0.229)
Low coverage (woman and her partner)		-0.108 (0.317)		-0.089 (0.317)
Crossed variables for hospital sector and supplementary private health insurance				
Private x High coverage (woman and her partner)		1.566*** (0.284)		0.476*** (0.092)
Private x High coverage (woman) and low coverage (partner)		1.513*** (0.441)		0.494* (0.299)
Private x Low coverage (woman) and high coverage (partner)		1.430*** (0.313)		0.472*** (0.126)
Private x Low coverage (woman and her partner)		0.845* (0.465)		0.551*** (0.151)
Demographic control variables	Yes	Yes	Yes	Yes
Medical control variables	Yes	Yes	Yes	Yes
Socioeconomic control variables	Yes	Yes	Yes	Yes
Hospital control variables	Yes	Yes	Yes	Yes
Observations (<i>N</i>)	30,333	30,333	29,088	29,088

Note: Robust standard errors clustered at the hospital level in parentheses. *** = 1% significance level, ** = 5%, * = 10%. All regressions use the main sample with complete socioeconomic data. Control variables include for demographics: age and parity; for medical risk factors: previous cesarean, diabetes, hypertension, eclampsia or preeclampsia, fetal growth restriction, placental disorder, other obstetric pathology, plurality, term at delivery, fetal presentation, induced labor, and birth weight; for socioeconomic status: woman's status of the couple, education, occupation, and work status, and her partner's occupation and work status; and for hospital characteristics: equipment level, teaching status, obstetrician availability, day of delivery, size, and numbers of full-time midwives, obstetricians, and anesthetists per occupied bed.
Data source: PCS, SAE, Yvelines district (France), 2008-2014.

Table A1. Descriptive statistics.

	Full sample		Public	Private
	<i>n</i>	Percent	Percent	Percent
Outcome variable				
Cesarean delivery	102,236	23.93	22.28	27.20
Woman's demographics				
Age (years)	102,236	30.73 (5.14)	30.34 (5.22)	31.52 (4.87)
Nulliparous	102,236	43.09	42.98	43.31
Woman's medical risk factors				
Previous cesarean	102,236	10.33	10.19	10.61
Diabetes	102,236	3.96	4.28	3.31
Hypertension	102,236	1.12	1.09	1.19
Eclampsia or preeclampsia	102,236	0.81	1.01	0.41
Fetal growth restriction	102,236	1.24	1.51	0.72
Placental disorder	102,236	0.24	0.25	0.22
Other obstetric pathology	102,236	7.13	7.99	5.44
Multiple pregnancy	102,236	1.46	1.68	1.04
Preterm delivery	102,236	5.04	5.81	3.51
Post-term delivery	102,236	0.12	0.13	0.11
Breech presentation or transversal lie	102,236	4.09	4.10	4.08
Induced labor	102,236	21.58	21.86	21.03
Low birth weight	102,236	5.48	6.43	3.62
High birth weight	102,236	7.07	7.04	7.12
Woman's socioeconomic level				
No partner	100,411	2.03	2.44	1.24
Education				
Primary school	79,428	2.66	3.23	1.55
Some secondary school	79,428	13.99	16.03	10.06
Completed secondary school	79,428	21.96	23.54	18.93
College or university	79,428	61.39	57.19	69.46
Occupation				
Manual worker	70,201	1.35	1.69	0.72
Office, sales, or service staff	70,201	55.17	58.73	48.62
Farmer	70,201	0.32	0.34	0.28
Craft/trades worker or entrepreneur	70,201	2.94	2.60	3.57
Intermediate (technical)	70,201	9.22	10.57	6.74
Managerial or higher intellectual	70,201	31.00	26.07	40.07
Work status				
Working	83,351	69.64	67.21	74.58
Unemployed	83,351	6.65	7.05	5.86
Not in labor force	83,351	23.71	25.75	19.57
Partner's socioeconomic level				
Occupation				
Manual worker	78,712	9.29	11.50	5.01
Office, sales, or service staff	78,712	40.12	43.16	34.25
Farmer	78,712	0.37	0.39	.32
Craft/trades worker or entrepreneur	78,712	7.33	7.10	.25
Intermediate (technical)	78,712	6.20	6.94	4.77
Managerial or higher intellectual	78,712	36.69	30.92	47.86
Work status				
Working	79,154	89.77	88.30	92.70
Unemployed	79,154	4.41	5.03	3.17
Not in labor force	79,154	5.82	6.67	4.12
Woman's location				
Rural	90,482	8.63	10.27	5.23
Hospital type				
Private	102,236	33.64	-	33.64
Level of equipment				
No neonatology unit	102,236	19.11	8.54	39.96
Neonatology unit	102,236	39.64	29.30	60.04
Neonatal intensive care unit	102,236	41.25	62.16	-
Teaching	102,236	37.49	56.50	-
Hospital organization				
On-call obstetrician outside the unit	102,236	9.09	-	27.02
Non-working day delivery	102,236	26.42	27.90	23.48

Size				
Small (< 1000 deliveries/year)	102,236	11.60	4.92	24.78
Medium (1000-1999 deliveries/year)	102,236	31.86	20.13	54.99
Large (\geq 2000 deliveries/year)	102,236	56.54	74.95	20.23
Midwives (FTEs/occupied bed)	102,236	1.10 (0.34)	1.28 (0.25)	0.74 (0.14)
Obstetricians (FTEs/occupied bed)	102,236	0.35 (0.11)	0.32 (0.10)	0.40 (0.11)
Anesthetists (FTEs/occupied bed)	102,236	0.39 (0.15)	0.41 (0.16)	0.36 (0.12)

Note: Means are given with their standard deviation in parentheses for continuous variables.

Data source: PCS, SAE, Yvelines district (France), 2008-2014.

Table A2. Effects of patient and hospital factors on cesarean deliveries. Multilevel logit models (coefficient estimates).

	1	2
Time		
Trend	0.001 (0.013)	0.000 (0.014)
Woman's demographics		
Age (years)	0.054*** (0.003)	0.055*** (0.002)
Nulliparous	1.200*** (0.074)	1.197*** (0.070)
Woman's medical risk factors		
Previous cesarean	3.071*** (0.117)	3.049*** (0.107)
Diabetes	0.235** (0.106)	0.225** (0.103)
Hypertension	0.511*** (0.091)	0.480*** (0.090)
Eclampsia or preeclampsia	1.295*** (0.166)	1.343*** (0.154)
Fetal growth restriction	0.775*** (0.240)	0.789*** (0.229)
Placental disorder	2.456*** (0.313)	2.474*** (0.363)
Other obstetric pathology	0.082*** (0.025)	0.117*** (0.033)
Multiple pregnancy	0.266 (0.187)	0.233 (0.180)
Preterm delivery	0.337*** (0.095)	0.333*** (0.102)
Post-term delivery	1.126*** (0.198)	1.182*** (0.203)
Breech presentation or transversal lie	3.515*** (0.133)	3.529*** (0.128)
Induced labor	0.136* (0.081)	0.147* (0.077)
Low birth weight	0.488*** (0.054)	0.474*** (0.061)
High birth weight	0.737*** (0.090)	0.744*** (0.091)
Woman's socioeconomic level		
No partner	-0.246** (0.099)	-0.257** (0.112)
Primary school	0.207** (0.105)	0.224** (0.108)
Some secondary school	0.282*** (0.048)	0.275*** (0.045)
Completed secondary school	0.248*** (0.032)	0.249*** (0.034)
Manual worker	0.225*** (0.076)	0.207** (0.085)
Office, sales, or service staff	0.123*** (0.038)	0.133*** (0.046)
Farmer	0.238 (0.354)	0.189 (0.411)
Craft/trades worker or entrepreneur	0.101 (0.070)	0.076 (0.073)
Intermediate (technical)	0.121*** (0.046)	0.114** (0.114)
Unemployed	0.126** (0.057)	0.134** (0.067)
Not in labor force	-0.057 (0.044)	-0.050 (0.040)
Partner's socioeconomic level		
Manual worker	0.138***	0.129***

	(0.048)	(0.044)
Office, sales, or service staff	0.126***	0.129***
	(0.029)	(0.030)
Farmer	0.034	0.121
	(0.223)	(0.284)
Craft/trades worker or entrepreneur	0.089	0.067
	(0.068)	(0.078)
Intermediate (technical)	0.066	0.066
	(0.050)	(0.057)
Unemployed	0.007	0.019
	(0.080)	(0.089)
Not in labor force	0.157***	0.156***
	(0.042)	(0.052)
Woman's location		
Rural		-0.048*
		(0.027)
Hospital type		
Private	0.582***	0.553***
	(0.168)	(0.187)
Neonatology unit	0.193**	0.223**
	(0.087)	(0.087)
Neonatal intensive care unit	0.316*	0.361**
	(0.180)	(0.183)
Teaching	0.116	0.109
	(0.119)	(0.130)
Hospital organization		
On-call obstetrician outside the unit	-0.036	-0.069
	(0.097)	(0.088)
Non-working day delivery	-0.528***	-0.520***
	(0.049)	(0.048)
Small size (< 1000 deliveries/year)	0.112	0.192
	(0.130)	(0.122)
Large size (≥ 2000 deliveries/year)	0.012	0.003
	(0.027)	(0.029)
FTEs midwives (/occupied bed)	-0.091	-0.110*
	(0.082)	(0.066)
FTEs obstetricians (/occupied bed)	-0.528***	-0.499**
	(0.201)	(0.195)
FTEs anesthetists (/occupied bed)	0.003	0.057
	(0.264)	(0.308)
Observations	58,645	52,927

Note: Robust standard errors clustered at the hospital level in parentheses. *** = 1% significance level, ** = 5%, * = 10%.
Data source: PCS, SAE, Yvelines district (France), 2008-2014.

Table A3. Effects of hospital sector on cesarean deliveries. Multilevel logit models (coefficient estimates). Hospital fixed-effects specification.

	1 All women	2 High medical risk	3 Low medical risk	4 Planned cesareans for low medical risk	5 Unplanned cesareans for low medical risk
Trend	0.019 (0.019)	0.024 (0.025)	0.005 (0.016)	0.002 (0.026)	0.001 (0.018)
Private	0.736*** (0.223)	0.701*** (0.258)	0.812*** (0.247)	1.602*** (0.401)	0.458** (0.217)
Demographic control variables	Yes	Yes	Yes	Yes	Yes
Medical control variables	Yes	Yes	Yes	Yes	Yes
Socioeconomic control variables	Yes	Yes	Yes	Yes	Yes
Hospital control variables	Yes	Yes	Yes	Yes	Yes
Observations (<i>N</i>)	58,634	28,307	30,327	30,267	29,082

Note: Robust standard errors clustered at the hospital level in parentheses. *** = 1% significance level, ** = 5%, * = 10%. All regressions use the main sample with complete socioeconomic data. Control variables include for demographics: age and parity; for medical risk factors: previous cesarean, diabetes, hypertension, eclampsia or preeclampsia, fetal growth restriction, placental disorder, other obstetric pathology, plurality, term at delivery, fetal presentation, induced labor, and birth weight; for socioeconomic status: woman's status of the couple, education, occupation, and work status, and her partner's occupation and work status; and for hospital characteristics: equipment level, teaching status, obstetrician availability, day of delivery, size, and numbers of midwives, obstetricians, and anesthesiologists per occupied bed.

Data source: PCS, SAE, Yvelines district (France), 2008-2014.

Table A4. Effects of hospital sector on cesarean deliveries. Multilevel logit models (coefficient estimates). Full sample without adjustment on socioeconomic characteristics.

	Hospital random-effects specification			Hospital fixed-effects specification		
	1 All women	2 Low medical risk	3 Planned cesareans for Low medical risk	4 All women	5 Low medical risk	6 Planned cesareans for Low medical risk
Trend	-0.001 (0.012)	-0.002 (0.011)	0.026** (0.012)	0.005 (0.012)	-0.005 (0.013)	-0.006 (0.020)
Private	0.426* (0.221)	0.488** (0.214)	1.216*** (0.216)	0.639** (0.248)	0.706*** (0.256)	1.389*** (0.342)
Demographic control variables	Yes	Yes	Yes	Yes	Yes	Yes
Medical control variables	Yes	Yes	Yes	Yes	Yes	Yes
Socioeconomic control variables	No	No	No	No	No	No
Hospital control variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations (<i>N</i>)	102,236	53,242	53,242	102,236	53,242	51,094

Note: Robust standard errors clustered at the hospital level in parentheses. *** = 1% significance level, ** = 5%, * = 10%. All regressions use the full sample with all observations. Control variables include for demographics: age and parity; for medical risk factors: previous cesarean, diabetes, hypertension, eclampsia or preeclampsia, fetal growth restriction, placental disorder, other obstetric pathology, plurality, term at delivery, fetal presentation, induced labor, and birth weight; for socioeconomic status: woman's status of the couple, education, occupation, and work status, and her partner's occupation and work status; and for hospital characteristics: equipment level, teaching status, obstetrician availability, day of delivery, size, and numbers of full-time midwives, obstetricians, and anesthetists per occupied bed.

Data source: PCS, SAE, Yvelines district (France), 2008-2014.

Table A5. Effects of hospital sector on cesarean deliveries, for planned cesareans versus normal deliveries. Multilevel logit models (coefficient estimates).

	Planned cesareans for low medical risk	
	1	2
Time		
Trend	0.040** (0.019)	0.040** (0.019)
Hospital sector		
Private	1.580*** (0.286)	
Supplementary private health insurance		
High coverage (woman and her partner)		Reference
High coverage (woman) and low coverage (partner)		-0.800 (0.542)
Low coverage (woman) and high coverage (partner)		0.018 (0.145)
Low coverage (woman and her partner)		-0.129 (0.303)
Crossed variables for hospital sector and supplementary private health insurance		
Private x High coverage (woman and her partner)		1.600*** (0.286)
Private x High coverage (woman) and low coverage (partner)		1.565*** (0.457)
Private x Low coverage (woman) and high coverage (partner)		1.473*** (0.319)
Private x Low coverage (woman and her partner)		0.864* (0.462)
<hr/>		
Demographic control variables	Yes	Yes
Medical control variables	Yes	Yes
Socioeconomic control variables	Yes	Yes
Hospital control variables	Yes	Yes
<hr/>		
Observations (<i>N</i>)	28,003	28,003

Note: Robust standard errors clustered at the hospital level in parentheses. *** = 1% significance level, ** = 5%, * = 10%. All regressions use the main sample with complete socioeconomic data. Control variables include for demographics: age and parity; for medical risk factors: previous cesarean, diabetes, hypertension, eclampsia or preeclampsia, fetal growth restriction, placental disorder, other obstetric pathology, plurality, term at delivery, fetal presentation, induced labor, and birth weight; for socioeconomic status: woman's status of the couple, education, occupation, and work status, and her partner's occupation and work status; and for hospital characteristics: equipment level, teaching status, obstetrician availability, day of delivery, size, and numbers of full-time midwives, obstetricians, and anesthetists per occupied bed.
Data source: PCS, SAE, Yvelines district (France), 2008-2014.