Documentos de Trabajo

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NON-ELECTIVE CESAREAN SECTIONS IN PUBLIC HOSPITALS: HOSPITAL CAPACITY CONSTRAINTS AND DOCTOR´S INCENTIVES

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Non-elective cesarean sections in public hospitals: hospital capacity constraints and doctor´s incentives

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Abstract

Using administrative records of births from the Perinatal Surveillance System of the Social Security System (ESSALUD) in Peru, we test whether high admissions of pregnant women affected unplanned cesarean section rates in the ESSALUD public hospitals during the period 2005-2006. To this purpose, we present a basic theoretical model that considers not only physician preference for leisure but also the effect of hospital capacity constraints. Based on inferences of this model, we find that physician demand for leisure increases the probability of a c-section in the smallest hospitals, while hospital constraints set a limit on the number of cesarean sections that can be performed. We discuss the policy implications of our findings and the policies implemented in ESSALUD to monitor the quality of obstetric services and avoid unnecessary or unjustified c-sections.

Keywords: Cesarean sections, public hospitals, leisure, capacity constraints, Perú

Running title: Non-elective cesarean sections in public hospitals

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1. Introduction

Cesarean sections have reached epidemic proportions worldwide and are growing particularly fast in developing countries over recent years. They account for 27% and 35% of the births in Asia and Latin America (Villar and others, 2006; Lumbiganon and others, 2010), and nearly half of all births in countries like China, Paraguay and Ecuador. These figures clearly exceed the recommendation of no more than 10-15% cesarean section births made by WHO,1985[2], and followed by other institutions like the Agency for Healthcare Research and Quality and the US Department of Health and Human Services (Fabri and Monfardini, 2008). The growing rates experienced during the last years in many developing countries have raised concern within the health community. On the one hand, unnecessary surgeries increase the risk for the woman and the baby (Althabe and Belizan, 2006), and raise healthcare costs (Clark et al. 1991; Keeler and Brodie 1993; Eckerlund and Gerdthamn 1996; Epstein and Nicholson 2005). On the other hand, the rising rates of cesarean delivery have the potential to divert human and financial resources from other, arguably higher priority, interventions (Triunfo and Rossi, 2009).

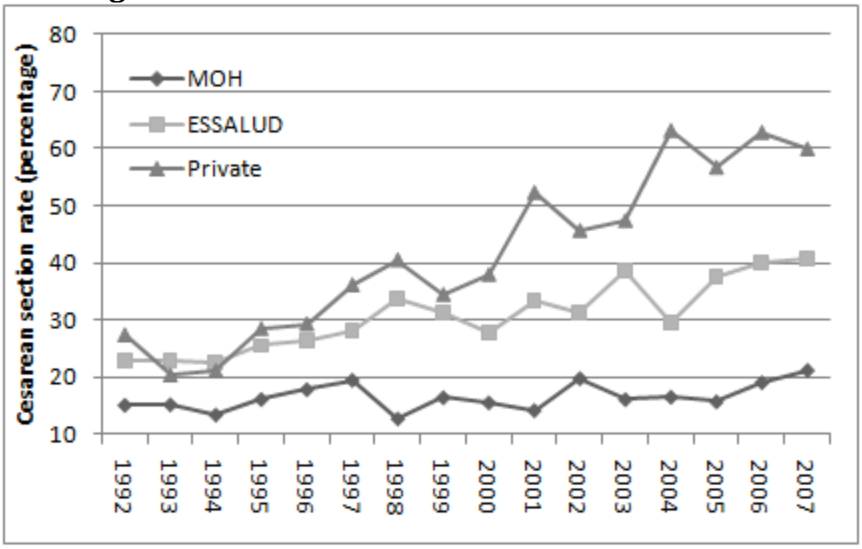
Since clinical and demographic factors have not adequately explained the increased ratio of c-sections, more efforts have been devoted to investigate the effects of non-clinical factors. Studies show that factors such as defensive medicine (Dubay et al, 1999), doctor’s demand for leisure (Brown, 1999, Mossialos, 2005), changes in the style of medical practice, and

[2] The WHO recommended rates are matter of debate (Althabe and Belizan, 2006) since it is a guideline established in 1985 based on the observed c-section rates in countries with the lowest perinatal mortality rate. Recently, WHO has stated that there is no empirical evidence for an optimum percentage".However, recommended rates by WHO, 1985 are still used as a reference in most of the literature on c-sections. Furthermore, despite the lack of consensus on the ideal rate for c-sections, there is agreement on the need to reduce those c-sections undertaken without clear medical justification.

changes in patients' attitudes towards cesarean sections (Lo, 2003; Lo, 2008) can induce more unnecessary cesareans in both public and private hospitals. Financial incentives have been also identified as an important factor increasing c-sections, especially in the private sector, where doctors usually work under a fee for service scheme (Gruber et al, 1999; Spetz, Smith, and Ennis 2001; Triunfo and Rossi, 2009). However, few studies have focused on other factors related to health-system variables, such as human resources availability or hospital capacity (Gibbons et al, 2010; Baicker et al, 2006). In addition, most of these studies do not disaggregate cesarean figures into different types of c-sections. It is important to distinguish among c-section types and observe their trends so as to design effective policies to reduce those deemed unnecessary.

In this paper we focus on the analysis of unplanned c-sections in public hospitals of ESSALUD in Peru. While higher cesarean delivery rates are mostly explained by the rise of elective c-sections (Gregory et al. 2002; Meikle et al. 2005), unplanned c-sections still represent a high proportion of them. Data from Latin America in 2006 show that 49% of c-sections are elective, 46% are intrapartum or unplanned and 5 % happen due to emergency (Villar et al, 2006). C-section rates in Peru have been increasing, especially in the last 10 years as shown in Figure 1. While cesarean sections almost doubled in the private sector during the period 1997-2002, they also increased notably in the public hospitals of ESSALUD.

Figure 1. Evolution of Cesarean Sections in Peru



Source: DHS 1996, 2000 and 2004-2007

In order to analyze unplanned c-sections in Peruvian public hospitals we explore the effect of hospital capacity and physician leisure preferences on c-section performance. We present a basic theoretical framework to primarily study the impact of hospital capacity constraints on decisions to perform cesarean sections when doctors are salaried and work in the public sector. The effect of capacity constraints on physician decisions has been studied in other contexts (Harris, 1977, Evans and Kim, 2006, Sharma et al, 2008). Fluctuations in hospital demand cause hospitals and physicians to ration capacity when faced with excess demand and, therefore, are relevant to study. Sharma et al, 2008 find that patients discharged on days when hospitals face high demand are discharged earlier than expected when compared to those discharged on days when demand is low. Similarly, Evans and Kim, 2006 examine the effects of unanticipated spikes in admissions on patient outcomes and find some evidence that large shocks to admissions on Friday and Saturday tend to reduce the length of stay and increase the chance of a subsequent readmission. However, these coefficients are very small and they do not find significant effects on health outcomes.

Our model shows that with idle capacity, salaried physicians may have incentives to perform c-sections as a way to have more leisure. However, when the hospital reaches maximum capacity, doctors are limited and constrained to apply c-sections. The model predictions are tested using a rich administrative data set from the Obstetric and Gynecologist departments of 34 public hospitals that are part of the Social Security System in Peru.

The paper is structured as follows: section two presents a simple model on physician choice under hospital capacity constraints, section three explains the data and the methodology employed; section four presents the results of the econometric analysis; and the final section discusses results and presents conclusions.

2. A basic model of physician choice with hospital capacity constraints

We focus on the analysis of unplanned or non-elective c-sections, so we can assume that the choice of c-section as a method of obstetric delivery is based on the obstetrician decision. We also assume that it is the obstetrician who attends all births. We outline here a simple interpretative model for obstetrician choice on the type of delivery, built upon the model presented by Gruber and Owing (1996).

Physicians are generally posited to have utility functions that depend positively on their income, leisure, and on delivering the "appropriate" amount of care. Gruber and Owing introduced the variable induction in their model since they were modeling a fee for service type of scheme. Inducement can be defined as the deviation of treatment levels from that which equates the marginal benefits and costs to patients (Fuchs, 1978; Gruber and Owings, 1996). Although we are modeling the behavior of a physician who earns a fixed monthly salary, we keep the variable inducement because we still expect some unnecessary c-sections to happen due to restrictions related to the obstetrician´s time and the hospital´s capacity. According to this, we pose that the obstetrician has a utility function of the form

$$\max_i U(Y, I, T) \qquad (1)$$

Where Y is full income and equals the total annual fixed salary W, I is the extent of inducement that causes the obstetrician disutility and T is the working time (1-leisure time) that we assume is a normal T* hours day. The number of births is B, and the level of inducement per birth is i, so that I=Bi; the total disutility from inducement depends on the total amount of inducement across all patients. The fraction of cesarean deliveries is a(i), which depends positively on inducement level. N is considered the number of vaginal births and C is the number of cesareans, while t_N and t_C are respectively the time devoted to attend a natural birth and a c-section. Since on average, a c-section requires less time than a vaginal delivery, we assume $t_N>t_C$.[3]

The obstetrician chooses i to maximize his utility U subject to a hospital capacity constraint to perform c-sections, like for instance the number of doctors, beds, equipment or operating rooms available to perform c-sections.

$$C \leq C^* \qquad (2)$$

Where:
$Y = W$
$I = Bi$
$T = t_N N + t_C C = t_N B + a(i)[t_C - t_N]$

[3] In the case of unplanned c-sections, it may happen that a c-section occurs in response to a very prolonged labor. In this case, $t_N \geq t_C$.

It can be shown that when the hospital has idle capacity, the effect of an exogenous change in the number of births on the proportion of c-sections is ambiguous:

$$\frac{\partial a(i)}{\partial B}_{idle\ cap} = \frac{U_{II}I+U_{TT}(t_C-t_N)a\prime(i)T}{-B^2a\prime(i)[U_{II}+U_{TT}(t_C-t_N)^2]} \gtreqless 0 \qquad (3)$$

An exogenous spike in admissions may push the doctor to perform more c-sections if the marginal benefit of more leisure time beats the marginal cost of not behaving according to “professional ethics”. This result is important because it shows that even without a fee-for-service reimbursement; doctors may have other incentives to perform cesareans. It also implies that within a fee-for-service payment, a policy to reduce c-section rates would require more than equalizing the rate of cesareans and vaginal deliveries, leading to pay more for a vaginal delivery.

However, when the hospital capacity constraint is binding, the effect of B on c-sections is strictly negative.

$$\frac{\partial a(i)}{\partial B}_{full\ cap} = \frac{C^*}{-B^2} < 0 \qquad (4)$$

Doctors will reach the maximum number of cesareans dictated by the hospital capacity and then will perform vaginal deliveries.

From this basic model, we can deduct that spikes in demand produce an ambiguous effect on cesarean sections when the hospital has idle capacity; and unambiguously reduce the cesarean rates when the hospital operates at capacity. We will test empirically these predictions in the next section.

3. Data and Empirical strategy

3.1.Data

We use two sources of data in this study. Our first source is an administrative data from the Perinatal Surveillance System (*Sistema de Vigilancia Perinatal*, SVP) of the Health Social Security System, ESSALUD, in Peru. ESSALUD is the name of the Social Security System in Perú, and is one of the three subsystems that conform the public sector. ESSALUD covers employees in the formal sector, while the Ministry of Health covers the poorest populations (unemployed or informal employees), and the armed force and police have access to their own hospitals. It is the private sector that serves the wealthiest populations.

The SVP was created in 1997 by means of an institutional agreement with the Cuban Government, and was implemented in 1998 by Cuban doctors, as a health information technology tool of the Perinatal National Peruvian Program. Getting evidence in real time about maternal and neonatal health together with the implementation of a managerial style based on evidence was intended to improve the quality of perinatal services in the public facilities of ESSALUD.

The SVP system collects information from 53 hospitals located in all regions of Peru. These hospitals have different levels of care: hospitals level I and II cover the second level of health care provision while hospitals level III and IV are those who provide third level services or more complex procedures. This leads to a larger risk concentration in hospitals III and IV, not only because they attend more complex cases but also because they receive referrals of the most complicated cases from hospitals in levels I and II and from primary health care facilities. We will consider three categories of hospitals for our analysis since tests of equality show no differences between the two types of high level of care hospitals (III&IV). The 53 hospitals in the sample represent 100% of ESSALUD hospitals level III and IV, 70% of the hospitals level II, and 30% of the hospitals level I, and they account for the 85% of births in ESSALUD, and 90% of neonatal deaths.

We obtained data from years 2005 and 2006 that included a total of 112,561 births. From the 53 facilities that report to the SVP, we excluded those with less than 1,000 births in years 2005 and 2006 (19 hospitals that account for 5.2% of births). As described in the empirical strategy, to improve the assessment of hospital capacity we only included the morning shifts (8:00am-3:00pm) and afternoon shifts (3:00pm-10:00pm) of non-holiday weekdays (46.5% of births in selected hospitals). We also excluded elective cesareans (21.7% of births in selected hospitals), except for the assessment of hospital's capacity. We focus on non-elective or unplanned sections (including emergency[4] and intrapartum[5] c-sections) because they seem to be more difficult to monitor than elective cesarean sections since the decision happens during the delivery. In fact, it can be hard to discriminate between non-elective c-sections that are mandatory and those that could have been a vaginal delivery, especially in the case of the intrapartum ones. The final sample used in the regression analysis included 33,428 births. Missing observations accounted for 1.04% of the final sample. A description of the sample is reported in Table 1.

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[4] Unplanned emergency c-sections happen when a woman is referred before onset of labour with a diagnosis of acute fetal distress, vaginal bleeding, uterine ruptura, maternal death with fetus alive, or eclampsia (Villar et al, 2006).

[5] Unplanned c-sections may happen intrapartum, i.e. indicated during labour, whether labour is spontaneous or induced (Villar et al, 2006).

Table 1. Sample Characteristics by Hospital Level of Care

	Level I	Level II	Level III&IV
Number of facilities	7	11	16
Number of births in 2005	4,799	3,908	15,052
Vaginal Delivery (%)	72.62	66.53	48.10
Elective CS (%)	19.09	25.49	32.07
Non-elective CS (%)	8.29	7.98	19.83
Number of births in 2006	4,695	4,171	14,743
Vaginal Delivery (%)	75.48	62.12	48.28
Elective CS (%)	16.85	28.96	32.90
Non-elective CS (%)	7.67	8.92	18.82
CS rate (%)	9.73	11.64	28.63
Number of births per day	4.69	2.83	7.52
Age (years)	28.60	29.51	30.00
Gestational age [<36 weeks] (%)	1.25	3.84	8.63
Gestational age [>42 weeks] (%)	0.62	1.31	1.19
Birth weight (grams)	33.98	32.87	32.69
Very low birth weight [<1,500 gr.] (%)	0.22	0.46	1.57
Low birth weight [1,500-2,500 gr.] (%)	1.26	3.68	5.17
High birth weight [>4,000 gr.] (%)	6.56	4.73	5.92
Congenit anomaly (%)	0.71	1.28	2.33
Number of previous deliveries	0.98	1.31	1.07
Number of previous CS	0.05	0.05	0.17
Number of abortions	0.23	0.30	0.34
Mother with any disease (%)	8.61	23.53	23.87
Mother with anemia (%)	4.07	5.65	3.34
Mother with pre-eclampsia (%)	2.39	3.72	3.54
Mother with bleeding during labor (%)	0.12	0.53	0.60
Mother with rupture placenta (%)	7.37	5.67	7.89
Mother with other complications (%)	5.33	8.35	13.35
Multiple birth (%)	0.21	0.83	2.75
Newborn with pathology (%)	2.36	5.53	7.11
Newborn died (%)	0.35	0.83	1.64
Newborn with APGAR at 1 min < 7 (%)	2.75	2.96	5.04
Sample size	7,787	5,875	20,118

Source: ESSALUD, Sistema de Vigilancia Perinatal 2005 and 2006.

Table 1 shows that elective c-section figures are higher than non-elective or unplanned. Both types of c-sections are higher in high complexity hospitals, reflecting that obstetric characteristics of women are more risky there. This justifies the decision to use subsamples according to hospital level of care for our empirical strategy described below. It is also interesting to note that for the two years under study, non-elective c-sections only grew for level II hospitals, decreasing around one percentage point in the case of high complexity and level I hospitals.

Our second source of data is a survey to all hospitals with more than 1000 births. The survey asked hospital unit directors for information about inputs in the obstetric and neonatology departments in fiscal year 2009, including staff, beds, equipment, and bed occupancy. The survey was developed and administered by the Perinatal National Peruvian Program of ESSALUD in the first quarter of 2010; 34 of the 36 hospitals in our final sample responded the survey. Some questions reported missing values or incomparable information. As a result, we selected five inputs that were reported with full information by the obstetric units: number of obstetric beds, number of doctors, number of obstetricians, number of sets for births, and number of sets for cesarean sections.

3.2. Empirical strategy

To estimate the probability that a woman has a c-section ($Prob[csec = 1] \equiv a_{iht}$), we use the following binary probability model:

$$a_{iht} = \beta_{1L} C_{ht}^{*} + \beta_{2L} B_{ht} + \beta_{3L} B_{ht} C_{ht}^{*} + \beta_4 X_{iht} + d_h + \varepsilon_{iht} \qquad (5)$$

where a_{iht} is the probability of having a c-section for woman i, in hospital h, at time unit t. C_{ht}* is a dummy variable that indicates if the hospital h operated at or near capacity on time t. B_{ht} is the total number of births at hospital h in time t. The interaction term $B_{ht}C_{ht}^{*}$ represents the number of births when the hospital h is capacity constrained. Estimates of

β_{1L}, β_{2L} and β_{3L} are obtained for each hospital level of care using dummy variables in the pooled regression.

We control for individual observable obstetric characteristics (X_{iht}), such as age, previous cesareans, and history of terminated pregnancies among others. We also include hospital fixed effects (d_h). To simplify the interpretation of marginal effects with interaction terms, we estimate equation (5) with a linear probability model corrected by heteroskedasticity. Estimations are produced separately for the morning shift and the afternoon shift because the parameters of interest are statistically different between shifts.

The parameters of interest are β_{2L} and β_{3L} (for each hospital level of care). β_{2L} is the marginal effect on c-sections caused by a spike in births when capacity is not binding. Our basic theoretical model predicts that this parameter could be positive (negative) if the marginal benefit of more leisure time is greater (lower) than the marginal cost of not behaving according to "professional ethics". $\beta_{2L} + \beta_{3L}$ captures the marginal effect of a spike in births on c-sections when the hospital is capacity constrained. From the theoretical model, we expect this effect to be negative.

Measuring hospital capacity

A hospital is capacity constrained when the quantity of inputs necessary to provide healthcare services is inadequate to meet realized demand. In this paper we focus on the hospital capacity to produce cesarean sections. In particular, our goal is to estimate C_{ht}*, which requires identifying the period of time *t* in which the hospital *h* operated at or near capacity. However, when it comes to the measure of hospital capacity, the literature does not offer a definite approach (Sharma et al 2008; Litvak et al 2008, Li and Benton, 2003). The standard strategy to assess hospital capacity uses occupancy per day based on number of beds, or other inputs. The first problem with this approach is the definition of the time interval. Within a day, a hospital faces different capacities and different demands. For example a hospital may operate with idle capacity in the night shift but full capacity in the morning shift when most elective cesarean sections are scheduled in advance.

To reduce the bias by the definition of time interval we select the sample and assess capacity constraints to the morning shifts (8:00am-3:00pm) and the afternoon shifts (3:00pm-10:00pm) as established in ESSALUD. It makes the time interval t for the estimation equation (5) equal to a shift-day. In addition, we use only non-holiday weekdays, because hospital capacity is reduced and unknown in holidays and weekends. Finally, we consider all deliveries in the assessment of capacity, including elective cesarean sections.

The second problem with the standard approach is that it fails to capture the technology in the production of healthcare. In particular, it omits the complementarity of all inputs in the production of healthcare services. For example, a hospital with unstaffed beds could be capacity constrained by a shortage of doctors, and still operate with empty beds. Furthermore, when applied to a facility or unit, the standard approach erroneously assume that inputs are perfect substitutes among services or specialties. For example, an Ob/GYN department could have enough beds or staff for vaginal deliveries but not for cesarean sections.

To overcome these problems, we use two approaches to identify if a hospital is capacity constrained in a shift-day. The first approach follows Sharma et al, 2008 and we name it as "the high demand approach". We identify as a high-demand shift-day the 20% of all non-holiday weekdays (morning and afternoon shifts separately) with the highest number of cesarean sections. Under the assumption that hospitals operate at or near full capacity, a high-demand shift day can also be defined as a shift-day with hospital capacity constraints. This is an indirect approach that avoids the use of inputs, but it may fail if the full capacity assumption is wrong. However, in ESSALUD this assumption may hold. There is a consensus in the public opinion and among directors of Ob/GYN departments in ESSALUD that their units operate at full capacity. Based on this definition, 38.9% of births in the morning shift and 48.1% in the afternoon shift were delivered when the hospital was at or near capacity.

Our second approach relaxes the full capacity assumption and exploits information about hospital inputs reported in the 2009 survey. We use Data Envelopment Analysis (DEA) to estimate the output-oriented efficiency [Banker et al, 1984, Charnes et al, 1994, Sarkis, 2000] of all 34 delivery hospitals that reported to the survey. DEA produces a relative technical efficiency based on multiple outputs and inputs. Our strategy to approximate hospital capacity is to find the maximum number of cesarean sections that a hospital can produce in a shift-day with five fixed inputs: number of obstetric beds, doctors, obstetricians, set of births, and set of cesarean sections. DEA will assign an efficiency value close to 1 to those hospitals that, relative to other hospitals, produce more cesareans with a given number of inputs. We consider that a hospital h is at or near capacity constrain in a shift-day t if the hospital's efficiency value is 0.75 or higher, and the shift-day t is a high demand shift-day based on the first approach. Based on this more stringent definition, 14.5% of births in the morning shift and 20.3% in the afternoon shift were delivered when the hospital was at or near capacity.

4. Results

Full regressions are presented in the Appendix. Tables 2 and 3 report marginal effect estimates of a change in births when hospital capacity is not binding (β_{2L}), and when hospital capacity is binding ($\beta_{2L} + \beta_{3L}$). Table 2 uses the first approach of hospital capacity assessment based on high demand shift-days. Table 3 uses the second approach based on DEA. Both tables report similar results that are consistent with the theoretical implications presented in section 2. First, when hospitals operate below capacity, the marginal effect of a spike in births on cesarean sections is negative and statistically significant for hospitals with high level of care (levels III and IV). For those hospitals, one additional birth reduces the probability of having a cesarean section by 1.3% in any shift. However, for hospitals in level I results differ according to shifts: negative in the morning shift and positive in the afternoon shift. Only in the afternoon shift, the marginal effect is statistically significant and positive, meaning that one additional birth increases the probability of having a c-section by 0.7%. Hospitals in level II show mostly negative and statistically significant results. When compared with capacity based on DEA (Table 3), the marginal effects are slightly lower, particularly for hospitals in level II, and levels III and IV.

Table 2. Marginal Effect of Spike in Births with Binding and Non-Binding Capacity on Probability – Capacity Defined according to the High Demand Days Approach

Marginal Effects	Level I	Level II	Level III&IV
Morning Shift			
Below Capacity	-0.003	-0.008**	-0.013**
	[1.86]	[11.91]	[54.88]
At or Near Capacity	-0.045**	-0.069**	-0.025**
	[109.65]	[82.47]	[206.39]
Afternoon Shift			
Below Capacity	0.007**	0.002	-0.013**
	[19.16]	[0.42]	[60.33]
At or Near Capacity	-0.029**	-0.037**	-0.029**
	[74.61]	[37.8]	[253.02]

Marginal effects from a linear probability model estimation corrected by heteroskedasticity. Below capacity refers to β_{2L}, at or near capacity refers to $\beta_{2L} + \beta_{3L}$. See appendix for the complete list of covariates included in the model.
F-test in brackets. Null hypothesis is that marginal effects are equal to zero.
* Reject the null at 5% significance level, ** Reject the null at 1% significance level.

Table 3. Marginal Effect of Spike in Births with Binding and Non-Binding Capacity on Probability – Capacity Defined with DEA

Marginal Effects	Level I	Level II	Level III&IV
Morning Shift			
Below Capacity	-0.005*	-0.006	-0.009**
	[4.85]	[2.72]	[28.63]
At or Near Capacity	-0.032**	-0.134**	-0.021**
	[29.17]	[83.58]	[95.25]
Afternoon Shift			
Below Capacity	0.002	-0.011*	-0.010**
	[0.84]	[4.71]	[33.3]
At or Near Capacity	-0.038**	-0.021*	-0.022**
	[44.33]	[5.84]	[92.63]

Marginal effects from a linear probability model estimation corrected by heteroskedasticity. Below capacity refers to β_{2L}, at or near capacity refers to $\beta_{2L} + \beta_{3L}$. See appendix for the complete list of covariates included in the model.
F-test in brackets. Null hypothesis is that marginal effects are equal to zero.
* Reject the null at 5% significance level, ** Reject the null at 1% significance level.

The second results refer to the marginal effect of a spike in births when hospitals are at or near capacity. For all hospital levels, this marginal effect is negative and statistically significant. When capacity is measured with high demand days, an increase in the number of births in levels III and IV hospitals reduces the probability of having a cesarean section in 2.5% in the morning shift and 2.9% in the afternoon shift. For other level hospitals, the effect is much higher, especially in the morning shifts. The marginal effects are similar when capacity is based on DEA (Table 3).

4.1. Methodological limitations

Although we control for obstetric risks, it could be argued that the probability of a cesarean section depends on other non-observable variables that are correlated with non-observed characteristics underlying the choice of hospital. For example, socioeconomic characteristics are not available in this administrative data, but they may be an important determinant of cesarean sections. This could lead to biased estimations, for example if there are hospitals with a high risk population.

This potential bias is small in our case since the population covered by ESSALUD has to go to a certain hospital according to the catchment area where they live. Therefore, there is not such a choice of hospital. Patients are only referred to other hospitals if they present explicit risks that are, for the most part, included in our controls. The database from SPV does not register the referral of patients to other hospitals, which would solve this limitation. Instead, in order to reduce the potential bias, we have included fixed effects by hospital and made three different estimations according to hospital level of care.

We have focused on births based on daily data instead of using a shorter period (for instance, shifts during the day). This may underestimate the effect of the hospital constraint as it might hide peaks of births on certain hours along the day. To avoid this problem, we have selected those hospitals that have more than 1,000 births in two years. If the bias still persists it is probably larger in the smaller hospitals (level I and II).

5. Discussion and conclusions

Cesarean sections are growing dramatically worldwide. Although the over provision of c-sections and other medical procedures have been commonly associated with private hospitals (Villar et al 2006, Arrieta 2010, Arrieta et al 2010), in this paper we show that demand increases may augment the utilization of unplanned or non-elective cesarean section in the public sector due to leisure preferences on the physician side. This finding applies to the smallest hospitals in the sample (hospitals in level I) and is aligned with previous papers that also identify a demand for leisure effect underlying the increase of cesarean sections (see Brown, 1996 for the USA, and Mossialos 2005 for Greek hospitals). In hospitals in level II, III&IV, the effect of physician preference for leisure on c-sections is not present. In fact, in those hospitals the increase of demand for deliveries reduces the probability of having a c-section. We also find that the existence of hospital capacity constraints limits the amount of cesarean sections that can be performed, and as a result, when the hospital reaches its capacity limit, the probability of having a c-section decreases. The overall effect of demand increase over non-elective cesarean section rates in the public hospitals of ESSALUD during the period 2005-2006 is null.

Two implications are derived from these results: (i) If ESSALUD decides to expand hospital capacity as it has been discussed lately, this might have an effect on the number of unplanned c-sections performed, particularly in the smallest hospitals. (ii) It is important to determine what factors are behind the effect of physician leisure preferences in the small hospitals as this effect is not found in the largest hospitals. A potential explanation may be the fact that since 1998, the hospitals of ESSALUD have conformed committees to monitor the quality of care provided by their obstetricians. In addition, as a part of the clinical protocols, before a c-section is performed the obstetrician has the obligation to consult with other colleagues and make a shared decision about the adequacy of a c-section. Further, ESSALUD hospitals are subject to regular medical audits of labor management. These measures seem to be working well in the ESSALUD public hospitals and contributing to the prevention of inadequate or unnecessary unplanned or non-elective c-sections, particularly in the largest hospitals. Small hospitals may not have the resources to monitor quality in the same way large hospitals are able to do. We had qualitative interviews with Peruvian obstetricians, confirming this finding. Other studies in the literature on c-sections show that measures such as those related above have also worked in other settings (Robson et al, 1996, Sloan et al, 2000, Salinas et al, 2004).

The finding on hospital capacity constraints as a contributor in reducing non-elective cesarean sections may seem trivial, but, nonetheless, it is relevant. Research on health care utilization in public and private facilities finds that the payment structure in the private sector lead to over-utilization of cesarean sections and other procedures (Gruber et al, 1999; Culyer, 1995; Ma, 1994, Hurley and Labelle, 1995). We show, nevertheless, that incentives for leisure time exist in the public sector and may also increase cesarean sections, as we found in the smallest hospitals of the sample. This effect is somehow counterbalanced by public hospital´s capacity constraints, which are not as frequent in the private sector. Whether the differences in cesarean section rates between private and public facilities are explained by differences in hospital capacity and/or by the type of incentives in place is a topic that warrants further research.

Finally, although we have focused on the analysis of unnecessary unplanned c-sections, the high incidence of elective c-sections in the period 2005-2006 in ESSALUD raise an interesting question: Are the committees or second opinion policies monitoring this type of c-sections? These committees seem to have worked in the case of non-elective c-sections, as we discussed above. Althabe et al 2004 find that the second opinion policy in several countries of Latin America worked mainly to prevent non-elective intrapartum c-sections, in particular, those related to non-progress of labour and fetal distress. A deeper analysis on which strategies would work best to reduce different types of c-sections might be of interest.

Appendix

Table A. Regression results by Working Shift and Definition of Capacity

	Capacity Definition			
	High Demand Days approach		DEA	
	Morning Shift	Afternoon Shift	Morning Shift	Afternoon Shift
Hospital Level I				
Capacity	0.441	0.464	0.29	0.45
	(0.029)**	(0.025)**	(0.047)**	(0.045)**
Births	-0.003	0.007	-0.005	0.002
	(-0.002)	(0.002)**	(0.002)*	(-0.002)
Capacity x Births	-0.043	-0.036	-0.027	-0.04
	(0.004)**	(0.003)**	(0.006)**	(0.006)**
Hospital Level II				
Capacity	0.487	0.558	0.678	0.539
	(0.032)**	(0.030)**	(0.053)**	(0.046)**
Births	-0.008	0.002	-0.006	-0.011
	(0.002)**	(-0.003)	(-0.003)	(0.005)*
Capacity x Births	-0.061	-0.039	-0.128	-0.011
	(0.008)**	(0.007)**	(0.015)**	(-0.010)
Hospital Level III & IV				
Capacity	0.347	0.435	0.364	0.391
	(0.013)**	(0.014)**	(0.027)**	(0.027)**
Births	-0.013	-0.013	-0.009	-0.01
	(0.002)**	(0.002)**	(0.002)**	(0.002)**
Capacity x Births	-0.012	-0.016	-0.012	-0.012
	(0.002)**	(0.002)**	(0.002)**	(0.002)**
Age (years)	0.007	0.006	0.007	0.006
	(0.001)**	(0.001)**	(0.001)**	(0.001)**
Age [<20 years old]	0.032	0.011	0.036	0.013
	(-0.018)	(-0.018)	(-0.019)	(-0.019)
Age [>34 years old]	0.014	0.015	0.019	0.02
	(-0.010)	(-0.010)	(-0.010)	(-0.010)
Gestational age [<36 weeks]	0.014	0.012	0.025	0.017
	(-0.014)	(-0.015)	(-0.015)	(-0.016)
Gestational age [>42 weeks]	0.09	0.059	0.088	0.066
	(0.025)**	(0.027)*	(0.027)**	(0.031)*
Birth weight (grams)	0.006	0.006	0.007	0.007
	(0.001)**	(0.001)**	(0.001)**	(0.001)**
Very low birth weight [<1,500 gr.]	0.09	0.043	0.097	0.07
	(-0.050)	(-0.055)	(-0.053)	(-0.058)
Low birth weight [1,500-2,500 gr.]	0.052	0.03	0.057	0.035
	(0.017)**	(-0.018)	(0.018)**	(-0.018)
High birth weight [>4,000 gr.]	0.058	0.085	0.064	0.09
	(0.014)**	(0.015)**	(0.015)**	(0.016)**

Congenital anomaly	0.06	0.042	0.058	0.038
	(0.025)*	(-0.026)	(0.027)*	(-0.027)
Number of previous deliveries	-0.06	-0.067	-0.066	-0.073
	(0.003)**	(0.003)**	(0.003)**	(0.003)**
Number of Previous C-sections	0.31	0.298	0.331	0.324
	(0.008)**	(0.009)**	(0.009)**	(0.009)**
Number of abortions	0.001	0.004	0.001	0.003
	(-0.004)	(-0.004)	(-0.005)	(-0.005)
Mother with any disease	-0.011	-0.018	-0.013	-0.026
	(-0.007)	(0.007)*	(-0.007)	(0.008)**
Mother with anemia	0.009	0.013	0.003	0.013
	(-0.012)	(-0.014)	(-0.013)	(-0.016)
Mother with pre-eclampsia	0.141	0.123	0.144	0.136
	(0.017)**	(0.017)**	(0.018)**	(0.018)**
Mother with bleeding during labor	0.136	0.183	0.169	0.185
	(0.051)**	(0.047)**	(0.055)**	(0.050)**
Mother with ruptured placenta	0.054	0.054	0.061	0.064
	(0.011)**	(0.011)**	(0.012)**	(0.012)**
Mother with other complications	0.105	0.093	0.115	0.102
	(0.011)**	(0.011)**	(0.012)**	(0.011)**
Multiple birth	0.283	0.348	0.305	0.39
	(0.026)**	(0.026)**	(0.028)**	(0.028)**
Newborn with pathology	0.026	0.031	0.027	0.039
	(-0.014)	(0.014)*	(-0.015)	(0.016)*
Newborn died	-0.084	-0.099	-0.095	-0.096
	(-0.057)	(-0.053)	(-0.059)	(-0.055)
Newborn with APGAR at 1 min<7	0.091	0.062	0.101	0.066
	(0.017)**	(0.017)**	(0.018)**	(0.018)**
Constant	-0.598	-0.707	-0.384	-0.77
	(0.040)**	(0.042)**	(0.040)**	(0.059)**
Sample size	17,331	16,097	17,331	16,097
R-squared	0.34	0.38	0.29	0.30

Linear probability model estimation, corrected by heteroskedasticity. Robust standard errors in parenthesis.
* Significant at 5%, ** Significant at 1%.

References

Agency of Health care research and quality, 2002. AHRQ quality indicators-Guide to inpatient quality indicators: quality of care in hospitals-volume, mortality and utilization. Rockville, MD.

Althabe, F., Belizán, JM, Villar, J, Alexander, S, Bergel, El, et al. 2004: Mandatory second opinion to reduce rates of unnecesary cesarean sections in Latin America: a cluster randomised controlled trial. The Lancet, 363, issue 9425: 1934-1940.

Althabe F, and Belizan JF. 2006. Caesarean section: The paradox. The Lancet 368:1472-3.

Arrieta, A., A. García-Prado, and J. Guillén, The Private Health Care Sector and the Provision of Prenatal Care Services in Latin America. *World Development*, 2011. 39(4): p. 579-587.

Arrieta, A., Health reform and cesarean sections in the private sector: The experience of Peru. *Health Policy*, 2011. 99(2): p. 124-30.

Baicker, K., Buckles, K.S., and Chandra, A.2006. Geographic variation in the appropriate use of cesarean delivery. Health Affairs 25(5):w355-w367

Banker, R.D., Charnes, A., Cooper, W.W., 1984. Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science* 30 (9), 1078–1092.

Brown III, H.S. 1996. Physician demand for leisure: implications for cesarean section rates. *Journal of Health Economics* 15:233-242.

Charnes, A., Cooper, W.W., Lewin, A.Y., Seiford, L.M., 1994. Data Envelopment Analysis: Theory, Methodology and Applications. Kluwer Academic Publishers.

Clark, L., Mugford, M., Paterson, C. 1991. How does the mode of delivery affect the cost of maternity care? *British Journal of Obstetrics and Gynecology*, 98:519-523.

Culyer, D. 1995. "The incidence of adverse medical outcomes under prospective payment," *Econometrica* 63.

Dubay L., Kaestner R., and Waidmann, T. 1999. The impact of malpractice fear on cesarean section rates. *Journal of Health Economics* 18: 491-522.

Eckerlund, I. and Gerdthamn, U. 1996.Variation in cesarean section rates in Sweden- causes and economic consequences. Centre for Health Economics-Stockholm School of Economics 106-3.

Epstein, A. and Nicholson, S 2005. The formation and evolution of physician treatment styles: an application to cesarean sections. Working Paper 11549, National Bureau of Economic Research.

Evans, W.N. and Kim, B. 2006. Patient outcomes when hospitals experience a surge in admissions. *Journal of Health Economics* 25: 365-388.

Fabbri, D. and Monfardini, C. 2008. Style of practice and assortative mating: a recursive probit analysis of cesareas section scheduling in Italy. *Applied Economics, Taylor and Francis journals, 40(11): 1411-1423*

Fuchs, V. 1978. “Values in Health: An Economist's Perspective,” in Helen Rehr (ed.), *Ethical Dilemmas in Health Care*, pp. 17-24, New York, USA.

Gibbons, L., Belizan, JM, Lauer, JA, Betran, AP, Merialdi, M, and Althabe, F. 2010. The Global Numbers and Costs of Additionally needed and Unnecessary Caesarean sections performed per year. Overuse as a barrier to universal coverage. *World Health Report,* Background paper 30.

Gregory KD, Ramicone E, Chan L, Kahn, KL.2001. Cesarean deliveries for Medicaid patients: a comparison in public and private hospitals in Los Angeles County. *American Journal of Obstetrics and Gynecology* 180:1177-84

Gruber, Jon, and others., 1999. “Physician Fees and Procedure Intensity: the Case of Cesarean Delivery*,” Journal of Health Economics* 18.

Gruber J. and Owings M. 1996. Physician financial incentives and cesarean section. *Rand Journal of Economics* 27:99-123.

Gruber J., Kim, J. and Mayzlin, D. 1999. Physician fees and procedure intensity: the case of cesarean delivery. *Journal of Health economics* 18:473-490.

Harris J.E.,1977. The Internal Organization of Hospitals: Some Economic Implications. *Bell Journal of Economics,* Vol. 8 (1977), pp. 467–482.

Hurley, Jeremiah, and Labelle, Robert. "Relative Fees and the Utilization of Physicians' Services in Canada," *Health Economics* 4, 1995.

Keeler, E.B. and Brodie, M. 1993. Economic incentives in the choice between vaginal delivery and cesarean section. *The Milkbank Quarterly*, 71: 365-404

Li, L., and Benton, W. C. 2003. Hospital capacity management decisions: emphasis on cost control and quality enhancement. *European Journal of Operational Research,* 146(3), 596-614.

Litvak, N., Rijsbergen, M., Boucherie, R.J., and Houdenhoven, M. 2008. Managing the overflow of intensive care patients. *European Journal of Operations Research 185:998-110*

Lo, J.C. 2003. Patient´s attitude vs physician´s determination: implications for c-sections. *Social science and medicine* 57(1):91-96

Lo, J.C, 2008. Financial incentives do not always work-an example of cesarean sections in Taiwan. *Health policy* 88:121-129.

Lumbiganon P, Laopaiboon M, Gülmezoglu AM, Souza, J.P, Taneepanichskul, S, Ruyan, P., Chuyun, K. et al. 2010. Method of delivery and pregnancy outcomes in Asia: the WHO global survey on maternal and perinatal health 2007—08. *The Lancet* **375**: 490-499.

Ma, Ching-To Albert, 1994. "Health Care Payment Systems: Cost and Quality Incentives," *Journal of Economics and Management Strategy* 3.

Meikle, S. F., C. A. Stiener, J. Zhang, and W. L. Lawrence. 2005. A National Estimate of the Elective Primary Cesarean Delivery Rate. Obstetrics and Gynecology 105 (4): 751-6.

Mossialos,E., Allin, S, Karras, K. and Davaki, K. 2005. An investigation of Caesarean sections in three Greek hospitals. The impact of financial incentives and convenience. *European Journal of Public Health*, 15(3):288-295.

Robson MS, Scudamore IW, Walsh SM. Using the medical audit cycle to reduce cesarean section rates. *Am. J. Obstet. Gynecol*. 1996 Jan;174(1 Pt 1):199-205.

Salinas, H., Carmona, S. , Albornoz, J., Veloz, P, Terra, R.et al. 2004. ¿ Se puede reducir el índice de cesárea? Experiencia del hospital clínico de la universidad de Chile. *Rev Chil Obstet Ginecol* 69(1):8-13.

Sarkis, J., 2000. A comparative analysis of DEA as a discrete alternative multiple criteria decision tool. *European Journal of Operations Research* 123: 543–557.

Sharma, R., Stano M, Gehering, R. 2008. Short-term fluctuations in hospital demand: implications for admission, discharge and discriminatory behavior. *Rand Journal of Economics* 2, 586-606.

Sloan, N.L, Pinto, E. Calle, A., Langer, A., Winikoff, B., Fassihian, G. 2000. Reduction of the cesarean delivery rate in Ecuador. *International Journal of Gynecology and Obstetrics* 69: 229-236.

Spetz, J., M. W. Smith, and S. F. Ennis. 2001. "Physician Incentives and the Timing of Cesarean Sections: Evidence from California." Medical Care 39 (6): 536-50.

Triunfo,P. and, Rossi, M 2009. The effect of physicians´remuneration system on the caesarean section rate: the Uruguayan case. *International Journal of Health Care Finance and Economics* 9(4):333-345.

US Department of Health and Human resources, 2000.Tracking healthy people 2010.Washington DC.

Villar, J., Valladares, E., Wojdyla, D., Zavaleta, N., Carroli, G., Velazco, A., Shah, A. et al 2006. Cesarean delivery rates and pregnancy outcomes: the 2005 WHO global survey on maternal and perinatal health in Latin America. *The Lancet,* 367 (9525): 1819-1829.