Style of practice and assortative mating:

a recursive probit analysis of cesarean section scheduling in Italy

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Abstract

We study practice variation in scheduling of cesarean section delivery across public and private hospitals in Italy. Adopting a novel perspective, we look at the role played by patients' preferences for the treatment. The recursive probit model is revisited as a useful tool to assess the presence of assortative mating of patients and provider driven by style of practice. According to our evidence the propensity to scheduling a cesarean section is codetermined with patient self-sorting into hospital types. We measure a significantly higher inclination to practice cesarean section scheduling in private hospitals and conclude that assortative mating is of minor relevance in our case, even if we cannot exclude it to be present.

Keywords practice variation, assortative mating, cesarean section scheduling, recursive probit model

J.E.L. I11, C15, C35, C52

1 Introduction

Persistent variation across geographic areas and across providers in the use of medical procedures represents a largely unexplained basic evidence in the health economics literature. A common view is that such pattern of variation emerges out of an asymmetric relationtioship between a subject patient and a dominant physician basically because of the disagreement across physician groups about the shape of the health production function, i.e. the function transforming medical care into health outcomes. This presumption seems hard to be rejected in the case of pure regional variation [1]. When we come to physician practice at least part of observed variation can be plausibly ascribed to a process of "*assortative mating* of doctors who are aggressive with patients who prefer aggressive treatment" (Phelps [2], page 251).

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The relation between style of practice and assortative mating has been surprisingly neglected in the literature despite its strong implications for patients' welfare. Whenever patients share homogenous preferences for "product" attributes, i.e. there is a single treatment that, being well informed, patients prefer [3,4], practice variation leads to a welfare loss. In these premises Phelps and Mooney [5] suggest that such a loss is of a comparable magnitude to the one emerging out of ex-post moral hazard in health insurance contracts and likewise impractical to be entirely recaptured to society. Targeted policies are invoked on a benefit-cost basis in the purpose of reducing welfare losses until marginal benefits pair marginal costs. Huge investments in the production and dissemination of novel evidence about the efficacy of various medical procedures are quite easy to justify in this framework [2]. On the contrary, whenever consumers have heterogenous preferences, provided they are able to identify provider treatment styles and are free to choose accordingly, then "product variety" will improve welfare. Ascertaining the existence of assortative mating mechanisms therefore lessens the argument in favor of active policies aimed at reducing practice variation and at the same time provides a rationale for policies aimed at improving patients' awareness of providers style of practice.

In this paper we take a first step in this direction and bring into focus the main ingredients to test for the existence of assortative mating in healthcare markets. Generally speaking, the analyzed case should be characterized by difference in style of practice across providers, patients' ability to observe provider's style of practice and quality, patients' heterogenous preferences for alternative treatments and free choice among alternative providers. Accordingly, the empirical model must be able to identify sistematic variation in practice across providers net of a full set of patients covariates, and to account for nonrandom selection of patients into hospitals. The source of the latter mechanism can be twofold: patients unobserved frailty and patients unobserved preferences for a given treatment. We show in the paper under which circumstances it is possible to interpret this self-selection mechanism as evidence of assortative mating.

We deal on a case study which has attracted a massive attention in the health economics literature. Cesarean section (CS) is one of the most common surgical procedure worldwide. In Italy and the US it is the second most frequent procedure with respectively 200,000 and 900,000 CS performed annualy. Quite some concern has been expressed about the increasing adoption of such a technology for birth beyond the realm of clinical abuse. According to OECD data CS incidence rose in developed countries from 6% in 1970 to more than 20% in 1998. This evidence conflicts with WHO (1985) recommendations on appropriate technology for birth, suggesting that "there is no justification, in any specific geographic region, to have more than 10-15% cesarean section births". Similar clinical guidelines have been proposed by the Agency for Healthcare Research and Quality [7] and by the US Department of Health and Human Services [8]. The conflict between clinical evidence and suggested guidelines stimulated quite some research efforts in the health economics literature to gain insights about the reasons behind this apparent overuse. Economists' contributions are deeply rooted into the so called Physician Demand Induction framework, i.e. the idea that in the face of negative income shocks, physicians may exploit their agency relationship with patients by providing excessive care [9]. Income shocks exploited in the literature arise from competitive pressure in the local market as measured by variation in physician density [10], from exogenous reduction in reimbursement tariffs [11], from declining fertility [12], from increasing threat of malpractice suit [13]. The role played by patients' preferences has been left unexplored in the health economics literature despite anecdoctal evidence of its relevance. According to MacKenzie [14] in 1996 30% of total antepartum cesarean section performed at the John Radcliffe Hospital in Oxford are on maternal request. This phenomenon was almost absent in the previous two decades. Al-Mufti *et al.* [15] suggest that 31% of London female obstetricians with an uncomplicated singleton pregnancy at term would choose an elective CS for themselves. Lo [16] provides evidence of significant increase in CS due to preferences for specific birthdays in China.A currently prevailing wisdom in the health policy literature seems to favour the idea that obstetricians' and patients' preferences jointly play a major role in determing delivery procedures [17, 18].

We present in this paper novel evidence about variation in treatment style for deliveries across two classes of providers, public and private hospitals, on a nationwide representative sample of Italian women in childbirth. We measure treatment style as the proportion of deliveries performed by CS in the two classes of hospitals. As it comes clear by looking at Table 1 CS rates are markedly different across the two classes mainly because of the private hospitals inclination to schedule CS. Conditional on laboring CS rates are indeed quite similar. Our general conjecture is that this difference in style of practice can be recognized by patients and drive, at least partially, a nonrandom self-sorting of patients into the two hospitals' types. Actually, scheduled CS cannot be viewed as a purely unilateral clinical decision a physician makes on behalf of his patient. It is made in large advance, allowing the patient to switch to another provider in case she disagrees with the scheduled decision. Moreover the extent of information asymmetry involved here between the physician and his patient seems quite limited: the set of alternative technologies for birth is small and the social knowledge about each alternative is spread and diffuse also in terms of their clinical implications. Finally patients preferences for the treatment are influenced by idiosyncratic factors like aversion to risk for the newborn, aversion to pain and suffering, taste for natural processes. These general features make scheduled CS a favorable case study for ascertaining the existence of assortative mating mechanisms. Some further aspects peculiar to our Italian case study are worth noticing here. First of all, in the italian NHS women are completely free to choose the treating hospital -public or private- with no out-of-pocket payments. Secondly, public and private hospitals are naturally sorted in terms of quality and infra-structural capacity. Public hospitals have emergency surgical capacity and newborn intensive care units (WHO [6] recommends that "natural deliveries after a caesarean should normally be encouraged wherever emergency surgical capacity is available"). On the other hand, private hospitals do not have emergency room and therefore are not allowed to admit on an emergency. Finally the presence of teaching personnel increases the role of professional and deontic rewards in the public leading to a higher propensity to improve clinical practices and to adopt the more appropriate ones. Because of these reasons, public hospitals are nationwide perceived in Italy as of higher quality for delivery. We exploit this quality difference in the interpretation of women self-selection mechanism into hospital type.

INSERT TABLE 1 HERE

To motivate our empirical analysis of assortative mating in scheduled CS we develop an interpretative model for the hospital choice and the delivery mode that incorporates the role of patient preferences for clinical and non clinical quality, aversion to risk and pain. We consider the scheduling decision as the possible outcome of a bargaining process between the physician and his patient. This process is conditioned, on the physician side, by deontic reasons and adherence to professional norms, financial incentives, overall clinical endowments in the operating hospital, fear for malpractice suit. On the patient side, bargaining is affected by preferences for the treatment, preferences for clinical and non clinical quality.

The econometric model we adopt acknowledges the binary nature of the endogenous variable represented by treatment: planned CS versus attempt of natural delivery (ND). The analysis of practice variation across public and private providers is performed by including among the determinants for the probability of the treatment a dummy indicating the provider chosen by the patient, beside a set of observable risk factors. Scheduling is jointly decided with provider choice, through an individual process in which patients' preferences for the alternative treatments and information on provider's style of practice play a major role. This brings about self-selection of patients into providers based on observables and unobservables characteristics that also determine the given treatment, making the provider dummy variable potentially endogenous. An adequate model to represent this phenomenon is the recursive probit model with endogenous dummy [19]. We propose a novel interpretation of it as a tool to assess the presence of assortative mating of patients and providers. In our revisitation, the main objects of the inference are the coefficient of the potentially endogenous dummy variable indicating the chosen provider, and the correlation coefficient between the error terms of the two equations. Through the first coefficient it is possible to evaluate the existence and the extent of the difference in style of practice across providers. The second coefficient signals the presence of a self-selection mechanism operating through unobservable variables. We explain in the paper that in presence of assortative mating both coefficients are expected to be non null.We find that the propensity to scheduling a CS across providers is codetermined with patient self-sorting into hospital type as hinted by the battery of exogenity tests we apply. We measure a significantly higher inclination to practice CS scheduling in private hospitals and conclude that assortative mating is of minor relevance in our case, even if we cannot exclude it to be present.

The paper proceeds as follows. In section 2 we elaborate an interpretative model for the hospital choice and the delivery mode. Section 3 presents our empirical model. Section 4 illustrates our case study, presents the estimation results and their interpretation. Section 6 contains some final remarks.

2 Understanding the decision process for cesarean section scheduling and hospital choice

We outline here a simple interpretative model for hospital choice and delivery mode. Our aim is to emphasise the role played by patients' preferences for the treatment. This simple model reflects some peculiar features in our case study.

For the sake of simplicity we consider that each individual belonging to the population of women in childbirth is described by an indicator r comprising all risk factors for a difficult delivery. We assume that the population is uniformly distributed between $\underline{r}$ and $\overline{r}$ in ascending order of risk. Women can deliver in only two available hospitals: a private one (PR-h) and a public one (PU-h). For ease of exposition we will consider the obstetrician and the hospital where he operates as interchangeable; in a sense we assume that the hospital is under the complete control of the staffed physicians and therefore implied agency problems are totally absent.

PU-h always provides appropriate treatments: in other words obstetricians operating there "unilaterally" follow professional guidelines for the purpose of gaining adequate deontic premiums (Frank [20] discusses unilateralism in clinical decisions within the paradigm of behavioral economics). The rule is like the following: if the women is of type r where $\overline{r} \geqq r \geqq r_{S_{PU}} > \underline{r}$ then schedule her a CS (action S_{PU}, where S stands for "scheduled" CS and the uppercase indicates that the clinical decision is appropriate); try a ND and therefore enter labor (action L_{PU}, where L stands for "labor") otherwise. No bargaining over the treatment is accomodated by the PU-h. The obstetrician operating in the PU-h always adopts appropriate unilateral clinical decisions, in a sense no economic argument enters their objective function.

On the contrary PR-h obstetrician is prompt to accomodate patients' preferences in accordance to his own objectives and therefore to bargain with the patient under the threat of patient's switch to the PU-h. The obstetrician operating in the PR-h might propose to his patient an appropriate scheduled CS (S_{PR}), a non appropriate scheduled CS (s_{PR}), or finally an attempt to ND (L_{PR}). S_{PR} is given according to a more lenient decision rule with respect to the PU-h (i.e. $r_{S_{PR}} < r_{S_{PU}}$). This is due to staffing and technical equipment limitations, as generally argued by [18], in the PR-h. Therefore appropriate scheduled CS is equally frequent across the two hospital's types conditional on staffing and technical equipment. s_{PR} is administred according to an even more lenient rule ($r_{s_{PR}} < r_{S_{PR}} < r_{S_{PU}}$), i.e. a rule that leads to a more frequent scheduling of a CS even after controlling for differences in staffing and technical equipment.

Coming to the payoffs, as far as PU-h are assumed to behave according to automatic unilateral rules, it is not an agent in our simple game. It simply represents the patient's outside option. Concerning the incentives for the PR-h we pose that by performing a S_{PR} the hospital/obstetrician gains an economic rent, A, comprising the anticipated diffential reimbursement of CS, time cost savings and lower efforts with respect to ND. Performing s_{PR} the economic rent A is reduced by a positive amount $a < A$ comprising the monetary equivalent for deontic penalties suffered by the obstetrician that overlooks his Hippocratic hoath. We assume that the deontic penalty is a decreasing function of the patient's risk indicator, $a(r)$, with $a_r < 0$. L_{PR} is associated to a positive payoff b reflecting the anticipated economic rents, plausibly smaller than those accruing for performing a scheduled CS, net of deontic penalties for performing a CS after labor. Therefore the payoff b is definitely lower than $A - a(r)$. We are now able to characterize the cutoff value for s_{PR}, $r_{s_{PR}}$, as the value of women risk indicator such that $A - a(r_{s_{PR}}) = b$. The decision to enter labor is always appropriate as far as there is no relative convenience to its overuse: it is never administered to a high risk patient, i.e. with $r > r_{S_{PR}}$.

We finally come to describe patient's payoffs and the implications these have on the outcome of the joint decisions of CS scheduling and hospital choice. We denote with B^c the payoff accruing to the patient in case the chosen provider treats her according to a clinical action c as defined above, with $c \in C = (S_{PR}, s_{PR}, L_{PR}, S_{PU}, L_{PU})$. Consider first the riskiest patients, i.e. those that have a risk indicator $r > r_{S_{PU}}$. They will value the highest the opportunity to receive a scheduled c-setion in PU-h: $B^{S_{PU}} > B^c \; \forall c \neq S_{PU}$. The very high risk patient alwas refer to PU-h as far as, conditional on her risk factors, she receives there an appropriate scheduled CS. Referring to PU-h is her best choice given that higher risk patients demand good unilateral clinical decisions.

We turn to the other tail of the risk distribution, i.e. patients with $r < r_{s_{PR}}$. PR-h obstetrician is to make them entering labor: the payoff for an appropriate ND is higher than that accruing to him in case of an inappropriate scheduled CS because of large deontic penalty. In this case, if the patient have a strong aversion to a painful and risky ND even in the public hospital, i.e. $B^{s_{PR}} > B^{L_{PU}}$, (we call this the "preference for scheduled CS" case) a bargaining between she and the private obstetrician might emerge. Her threat of switch to the public hospital makes the bargaining over scheduled CS beneficial for the PR-h in face of the loss of a patient. Gain from bargaining is equal to $A - a(r)$; concomitantly, for the patient it is equal to $B^{s_{PR}} - B^{L_{PU}}$. Assuming a very simple Nash bargaining framework [21] we can state a patient with risk profile $r < r_{s_{PR}}$ will refer to PR-h and receive an inappropriate scheduled CS as far as the the following inequality is satisfied:

$$(A - a(r))^{\gamma} \cdot \left(B^{s_{PR}} - B^{L_{PU}}\right)^{1-\gamma} > b^{\gamma} \cdot \left(B^{L_{PR}} - B^{L_{PU}}\right)^{1-\gamma}$$

where γ represents bargaining power of the obstetricians and $1-\gamma$ that of his patient. As the bargaining power of the physician decreases the more frequent is the scheduling of an inappropriate CS. The choice of a PR-h and the concomitant scheduling of an inappropriate CS is therefore more (less) frequent the lower (higher) is the bargaining power of the hospital/obstetrician, the stronger (weaker) are economic incentives on the PR-h, the higher (lower) is patient's riskiness, the larger (lower) is patient aversion to pain and suffering.

For a patient located in the middle of the risk distribution $r \in (r_{s_{PR}}, r_{S_{PU}})$ an interesting barganing over treatment choice might emerge with the PR-h in case she has a peculiar preference structure given by the following ordering of payoffs: $B^{L_{PR}} > B^{S_{PR}} > B^{s_{PR}} > B^{L_{PU}}$ (we call this the "preference for ND in private" case). Here, the patient is highly valuing non clinical quality aspects provided by a private hospital and is willing to have a ND. In this circumstances the PR-h can be forced to bargain under the threat of patient's switch. The decision not to schedule a CS (either appropriate or inappropriate) emerges provided the following inequalities holds

$$A^{\gamma} \cdot \left(B^{S_{PR}} - B^{L_{PU}}\right)^{1-\gamma} < b^{\gamma} \cdot \left(B^{L_{PR}} - B^{L_{PU}}\right)^{1-\gamma} \qquad \text{for } r \in (r_{S_{PR}}, r_{S_{PU}})$$

$$(A - a(r))^{\gamma} \cdot \left(B^{s_{PR}} - B^{L_{PU}}\right)^{1-\gamma} < b^{\gamma} \cdot \left(B^{L_{PR}} - B^{L_{PU}}\right)^{1-\gamma} \qquad \text{for } r \in (r_{s_{PR}}, r_{S_{PR}})$$

The latter inequality, referring to the less risky patients in the middle of the distribution, is more easily met. The economic rent accruing to the provider net of deontic penalties for inappropriate planned CS is smaller and patient gain over an admission in the PU-h is smaller as well in case an inappropriate CS is proposed. Notice that in the "preference for ND in private" case no bargaining arises if $r < r_{s_{PR}}$ given that both agents agree on the decision to attempt to a ND.

Pattern of choices without bargaining can emerge once we consider other preference structures. For instance, patients with medium to low risk indicator may have strong prefences in favour of a natural and safe delivery, i.e. a ND attempted in a more endowed public hospital. We call this the "preference for ND in public" case.

3 The empirical framework

We depict here a simple empirical framework to assess the existence of assortative mating. Coherently with our interpretative model we start by defining a latent variable indicator $s_i^* = f(r_i)$ so that the dichotomus choice of scheduled CS vs the attempt of a ND s_i is observed according to the rule:

$$\begin{cases} \text{"schedule a CS":} & s_i = 1 \quad if \quad s_i^* > 0 \\ \text{"attempt a ND":} & s_i = 0 \quad if \quad s_i^* \leq 0 \end{cases}$$

Such a choice can be interpreted, conditionally upon risk and predisposing factors r_i, as an "unilateral", purely deontic decision rule for a patient delivering in a public hospital. The decision rule shifts from such a "golden standard" in case the woman chooses to deliver in a private hospital. In a sense we consider the obstetricians operating in public hospitals as "professional leaders" setting the professional norm the collegues operating in private hospitals look at. Assuming a parametric linear specification, the scheduling decision emerges then according to the latent regression:

$$s_i^* = \delta_1 priv_i + f(r_i) = \delta_1 priv_i + \delta_2 z_i + u_{si} \tag{1}$$

where $priv_i$ is a dichotomous variable indicating delivery in private hospital, z_i is a vector collecting exogenous observable risk and predisposing factors, while u_{si} is a stochastic term capturing all the unmeasured characteristics of the woman. The above equation reflects the outcome of a joint decision process involving the two agents. We would like to interpret the difference in probability of scheduling in private hospitals with respect to public as a measure of private departure from the public appropriate, professional norm.

However, as we argued above, the hospital choice is concomitant to the scheduling process, in some cases even subject to strategic bargaining considerations. The woman may choose to opt out of a public hospital admission aware of her health conditions, hospital characteristics and the clinical decision rule adopted there. Therefore the two classes of hospital will attract women with different preferences and different clinical characteristics. Some of these determinants are observed, other are not, forcing us to consider equation 1 jointly with a hospital choice process. This process is driven by the following stochastic latent indicator:

$$priv_i^* = \beta_1' x_i + u_{hi} \tag{2}$$

and determines the observable variable $priv_i$ according to the rule:

$$\begin{cases} \text{“refer to PR-h”} & priv_i = 1 \quad if \quad priv_i^* > 0 \\ \text{“refer to PU-h”} & priv_i = 0 \quad if \quad priv_i^* \leq 0 \end{cases}$$

The vector x_i contains exogenous observable risk factors and socio-economic characteristics of the woman and u_{hi} is a stochastic error term. Omission of common unobservable variables in equations 1 and 2 introduces a correlation pattern between the two stochastic components (u_{si}, u_{hi}). Adding to equations 1 and 2 the assumption that the latter are independently and identically distributed as bivariate normal:

$$\begin{pmatrix} u_{si} \\ u_{hi} \end{pmatrix} \sim IIDN\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix} \right) \tag{3}$$

results in a bivariate probit model with endogenous dummy. This model belongs to the general class of simultaneous equation models with both continuous and discrete endogenous variables introduced by Heckman [19]. Maddala [22] lists this (as Model 6) among the recursive models for dichotomous choice. The recursive structure builds on a first reduced form equation for the potentially endogenous dummy (the hospital type choice equation 2 in our case)- and a second structural form equation determining the outcome of interest (the scheduling decision process 1).

Some hints on the interpretation of the correlation coefficient ρ in our modelling exercises can be obtained putting forward the following simplifying decomposition of the two error terms of the model:

$$\begin{aligned} u_{si} &= \varphi_1 \varepsilon_{ri} + \varphi_2 \varepsilon_{pi} + \eta_{1i} \\ u_{hi} &= \gamma_1 \varepsilon_{ri} + \gamma_2 \varepsilon_{pi} + \eta_{2i} \end{aligned}$$

where ε_{ri} indicates unobserved adverse clinical conditions relevant for delivery, ε_{pi} represents her unobservable tastes in favour of a ND (like degree of aversion to pain and suffering, taste for natural processes), while η_{1i} and η_{2i} are the residual unobserved random component of the two latent indicators, normally distributed with zero mean, variances $\sigma_{\eta 1}^2$ and $\sigma_{\eta 2}^2$ respectively, uncorrelated with each other. For the sake of simplicity, we assume that ε_{ri} and ε_{pi} are normal, zero mean, uncorrelated with each other and with η_{1i} and η_{2i}, with variances σ_r^2 and σ_p^2 respectively. The variances of the two idiosyncratic components, $\sigma^2_{\eta 1}$ and $\sigma^2_{\eta 2}$ are assumed to get values making the normalization $Var(u_{1i}) = Var(u_{2i}) = 1$ to hold. In this setting, the correlation between the error terms of the two probit equations arises only from the two common unobserved components ε_{ri} and ε_{pi}: $\rho = E(u_{1i}, u_{2i}) = \gamma_1\varphi_1\sigma^2_r + \gamma_2\varphi_2\sigma^2_p = \rho_r + \rho_p$. This splits the correlation coefficient into two parts: the first term ρ_r captures a selection mechanism related to clinical risk, the second one ρ_p, relates to the preferences of the woman. The coefficients γ_1, γ_2, φ_1, φ_2 are clearly not identifiable, but are inserted because speculating on their sign according to the assumptions presented in section 2 we are able to provide some possible interpretations of the identified correlation coefficient ρ. Coherently with the discussion of the previous section we can derive the following implications. Concerning the risk component, $\gamma_1 < 0$ and $\varphi_1 > 0$, i.e. $\rho_r < 0$. This means that the more frail patient refer to the higher quality hospital, the public one in our case. This kind of nonrandom selection to hospitals has been strongly evidenced by Geweke *et al.* [23]. Turning to the unobservable preference component, its sign is more controversial. Recalling the alternative preference patterns sketched above, in the "preference for schedule CS" case we expect $\gamma_2 < 0$ and $\varphi_2 < 0$. "Preference for natural in public" case is compatible with $\gamma_2 > 0$ and $\varphi_2 > 0$. Finally, in the "preference for natural in private" case $\gamma_2 < 0$ and $\varphi_2 > 0$. If we are to discard this last pattern on the ground of its little empirical relevance, it is possible to state that preference component ρ_p is positive. When the self-sorting mechanism due to unobservable preferences can be ascribed to a recognizable practice variation across providers, then assortative mating can be claimed to be in place. In the above context, this implies $\rho_p > 0$ and $\delta_1 > 0$. Given that the identified parameter is ρ, the practical implementation of a test for the presence of assortative mating is confronted with the difficulty represented by the presence of the risk component ρ_r. The negative (positive) sign of ρ testifies that the risk component ρ_r (preference component ρ_p) prevails upon the other. The relative importance of the two components is an empirical matter. The richer the set of risk control available to the researcher the larger will be the role played by the patient unobserved preference and the scope for assessing the existence of assortative mating.

The implications for the empirical tests are the following. When the correlation coefficient is found to be statistically equal to zero, the evidence about assortative mating is inconclusive, but the resulting exogeneity of the dummy allows to use only the treatment equation for investigating practice variation. Second, a significant impact of provider's dummy toghether with a positive correlation coefficient testifies the existence of assortative mating (while a negative correlation coefficient does not allow to draw any conclusion on this mechanism).

4 Scheduling Cesarean Section delivery and self-selection into hospital types in Italy

4.1 Data description

We work on a dataset coming from the "Indagine Statistica Multiscopo sulle Famiglie: condizioni di salute e ricorso ai servizi sanitari" (ISMF), a national household survey conducted by the Italian National Institute of Statistics (ISTAT) every 5 years. The last available survey was conducted from september 1999 to august 2000 when a sample of 40119 households were interviewed. The survey provides a full account of individual health condition, health care utilization, biometric parameters plus socio-economic status (education, working condition) and other relevant economic variables like complementary private health insurance holding. In this study we exploit a section of the survey focussing on the last delivery experienced by female components of each sampled household in the five years before the interview. Delivery experience is described in an individual self-compiled part of the survey. Data about mode of delivery, health problems suffered and therapies underwent during pregnancy and delivery are self-reported. Therefore we do not rely on approximate methods based on administrative data, like the one used by Epstein and Nicholson [24], to identify CS scheduling. This is critical in case of strategical miscoding. We have 5660 women filling in this section of the survey for a corresponding number of deliveries. However, for data coeherency, we decided to use only those delivering in the four years before the interview. We therefore ended up with a sample of 4516 observations.

We control for a full set of variables (see the following Table 2 for a list, and table A.1 in the Appendix for descriptive statistics) including individual predisposing risk factors for CS delivery and some socioeconomic variables. Theoretical identification of the recursive probit model is achieved as soon as both equations of the model contains a varying exogenous regressor [25]. However, to avoid that identification strongly relies on model's functional form we insert among the x_i the following additional instruments: a dummy indicating whether the woman has a self-employed occupation, and a set of dummy variables conveying information on the residential area. Given the self-compiled nature of the questionnaire our set of risk factors do not include most of the clinical conditions usually controlled for in the health econometrics analysis of CS variation (see for example[13]). Major lacks are controls for breech presentation, fetal distress and prior CS. The latter variable is known to be a major predisposing factor for CS delivery. In order to overcome this limitation we exploit information about primiparity. However we are only able to approximately identify primiparae women. We code as primipara a woman with no other natural children living in their family older than that the surveyed delivery refers to. This strategy is quite plausible provided that in Italy almost all children are placed in the care of their mother in case of parents divorce. According to this identification criterion, primiparas are about 40% of our national sample, a "realistic" proportion in Italy. We include this dummy for primiparity and its interaction with the dummy indicating wheather the woman is aged more than 36 in a second specification of the model. We report the estimation results for both specification as Model 1 and Model

2 hereafter.

INSERT TABLE 2 HERE

4.2 Main results

Table 3 presents the main findings emerging from the following specifications: univariate probit, seemingly unrelated bivariate probit, and recursive probit model. To obtain MLE of the latter models, we resorted to the command "biprobit" of STATA 9, which exploits the Newton-Raphson maximization method and allows for Hessian-based estimation of the asymptotic covariance matrix. Such command, presented in STATA only for the SURE bivariate probit, sorts out the correct estimation procedure also when one of the dependent dichotomous variable is included as a regressor for the other probit equation, as the two models share the same log-likelihood "mechanics". In the recursive probit model the PRIVATE dummy proves to be positive and highly significant, picking up hospital specific factors that increases the probability of a scheduled CS. To evaluate the exogeneity status of this dummy we compute alternative exogeneity tests analysed in Monfardini and Radice [26]: conditional moments (CM), different versions of the lagrange multiplier test (LM1, LM2, LM3, LM4), likelihood ratio (LR) and the Wald-type test based on the esimated value of the correlation coefficient (RHO). As expected, find that the dummy is endogenously codetermined with the scheduled CS equation. The battery of exogeneity tests presented in the bottom part of the table provides conflicting indications at a first sight. The CM, LM1, LR and RHO tests lead to strong rejection of the hypothesis of exogeneity, while LM2, LM3 and LM4 support the opposite evidence, i.e. in favour of exogeneity of the hospital type dummy. However, the Monte Carlo evidence presented in [26], helps in distinguishing and interpreting these results, as the latter set of tests exhibit finite sample distributions remarkably far from the asymptotic ones. This leads us to conclude that in our case study the bivariate endogenous dummy model is the appropriate setting for drawing some consistent inference on hospital type differences in CS utilization rates.

INSERT TABLE 3 HERE

A full account of the bivariate endogenous dummy probit estimation exercise is available in the Appendix. For the sake of brevity we only notice here that overall results are coherent with expected signs. Each risk factor contributes to increase the probability of scheduling a CS, while they are almost uniformly not significant in driving hospital choice. A noticeable exception is represented by newborn weight: babies with low weight at birth are less frequently delivered in a private hospital. Socioeconomic variables (education) seem to be irrelevant in determining CS planning probability with the exception of insurance holding. However, being self-employed, holding a private health insurance and being more educated makes the woman to have a higher probability to deliver in a private hospital. The coefficients of the primipara dummies in Model 2 imply that a woman delivering for the first time is less likely to deliver with a scheduled CS when younger than 36, but more likely to do so when aged more than 36. In broader terms, if we restrain ourselves to the individual observable effects, it seems that scheduling is driven, as expected, by some relevant risk factor but is less so by socio-economic variables. The reverse applies to the decision to opt for a private admission. Even more coarsely we could say that according to observables CS scheduling is a clinical matter and opting to a private hospital has to do with socio-economics.

Turning to the two main coefficients of interest, the following comments apply. The negative and significant correlation coefficient suggests that among the two self-selection forces we figured out in section 3, the one related to preferences is dominated by the unobserved frailty one. This allocates the more risky patients to public hospitals, i.e. the higher quality hospitals. The significant and positive dummy coefficient indicates that, net of observable and unobservable confoundings, we measure a significantly higher inclination to practice CS scheduling in private hospitals. This is, as we suggested, a precondition to interpret the correlation coefficient in the light of assortative mating mechanism. Because of its measured negative sign, we conclude that assortative mating is of minor relevance in our case, even if we cannot exclude it to be present. It is worth noticing that according to the bivariate SURE probit model the estimated correlation is positive and therefore apparently coherent with an opposite interpretation of the self-selection process at work. As the SURE model is actually nested in the endogenous dummy one, we are able to conclude that the former is rejected, with the coefficient of the dummy being significantly different from zero. Moreover, the consequent structure is functional to a meaningful profiling analysis of healthcare providers [27].

INSERT TABLE 4 HERE

In Table 4 we look at the appropriate scheduled CS probability differentials to evaluate the impact of the PRIVATE hospital dummy for a set of representative women. These are characterized by different risk factors and primiparity status. Given the lack of major risk factors in our specification, the considered profiles describe intermediate levels of riskiness r_i. Therefore, in line with our intepretative model of section 2, these representative women may concretely switch to a private hospital. Incidentally we notice that, coherently with our framework of section 2, the more risky woman is less likely to refer to a private hospital. For all typical women the impact of the PRIVATE hospital dummy is positive and significant as emerges from column (6) where we evaluate the standard error of the difference through the Delta method. Our low risk primipara when uninsured has a probability of 8.65% of getting a scheduled CS in public hospitals, increasing to 15.32% when she refers to a private one. It is worth noticing here that these figures lie below the target set for low risk primiparas in the US Department of Health and Human Resources plan "Tracking Healthy People 2010" [8]. Our assertion on public hospitals practice as representing the appropriate, professional norm suggests to look for a measure useful for evaluating the extent to which private hospitals move away from this golden standard. To this purpose, we compute the percentage change of the probability of receiving a scheduled CS in private with respect to the corresponding figure in public hospitals. For the primipara high risk woman such percentage difference is equal to 42%. For her low risk counterpart the percent change reaches a huge 77%, i.e. almost doubled. The observed percentage difference across risk profiles is enormous indicating that in our case study private hospitals scheduling practice exceeds the public norm the more the less risky is the patient.

5 Conclusions

We study practice variation in scheduling of cesarean section delivery across public and private hospitals. In the health economics literature the prevailing approach ascribes variation in CS adoption to physician unilateral response to a broad set of economic incentives. We adopt here a novel perspective and look at the role played by patients' preferences for the treatment, allowing for the presence of an assortative mating process driven by provider style of practice. We discuss which circumstances make it feasible an empirical assessment of assortative mating in healthcare markets and argue that our case study is well suited to this purpose.

The econometric model adopted for the endogenous discrete variable represented by treatment is Heckman's recursive probit model. The analysis of practice variation across alternative providers is performed by including among the determinants for the probability of the treatment, a dummy variable indicating the provider chosen by the patient. The latter is determined by an individual choice process in which patients' preferences for the alternative treatments and information on provider's style of practice play a major role. This brings about self-selection of patients into providers based on observables and unobservables characteristics that also determine the given treatment, and makes the provider dummy variable potentially endogenous. Unobserved variables are both related to patient's preferences and unobserved severity conditions. The first set originates a nonrandom selection which has to do with assortative mating, and implies a positive correlation coefficient. However, this effect can be partially or totally offset by a self-selection of opposite sign introduced by the second set of unobservables. The negative sign of the latter is a mantained assumption that finds sound justification in the higher quality of public hospitals, attracting women with more severe unobservable conditions.

In our case study on an Italian sample we obtain strong evidence against the hypothesis of exogeneity of hospital type dummy in the equation determining CS scheduling probability. Our results suggest that a self-selection mechanism allocating the more risky patients to public hospitals is prevailing over the assortative mating mechanism operating through unobservable preferences for the treatment. After controlling for observable and unobservable characteristics, women admitted to a private hospital are more likely to receive a scheduled CS at any risk profile. Thus, working in a private hospital seems to insulate the physicians from the adherence to a prevailing professional norm set by their public hospital counterparts. Looking at the percentage change of the probability of receiving a scheduled CS in private with respect to the corresponding figure in public hospitals, we find that in our case study private hospitals scheduling practice exceeds the public norm the more the less risky is the patient.

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TABLES TO BE INSERTED IN THE MAIN TEXT

Table 1. Cesarean section (CS) incidence across hospital types

	CS rate	Scheduled CS rate	CS rate conditional on laboring	"Market" Shares
Public hospital	27.5%	16.9%	12.8%	91.4%
Private hospital	42.4%	32.3%	14.9%	8.6%
All	28.8%	18.2.%	12.9%	100.0%

Table 2. Variables description

Variable	
Scheduled	=1 if woman delivers with a scheduled cesarean section; =0 otherwise
Private	=1 if woman delivers in a private hospital; =0 otherwise
	Risk Factors
Primipar	=1 if woman delivers for the first time; =0 otherwise
Amniocen	=1 if the woman underwent early prenatal diagnostic checks ("villi coriali" or "amniocentesi"); =0 otherwise
Diabetes	=1 if the woman self-reports having suffered from diabetes during her pregnancy; =0 otherwise
Gestosis	=1 if the woman self-reports having suffered from "gestosi" during her pregnancy; =0 otherwise
Hyperten	=1 if the woman self-reports having suffered from blood hypertension during her pregnancy; =0 otherwise
BMI	Body Mass Index (=bodyweight/(height/100)^2)
Newborn weigth	weight of the newborn in kilograms
Newborn weigth sq	weight of the newborn squared
No. scans	number of fetal ultrasound scans done during pregnancy
Hospitalization	=1 if the woman was admitted to hospital during her pregnancy; =0 otherwise
Smoked	=1 if the woman was an abitual smoker; =0 otherwise
Age +36	=1 if woman is older than 36; =0 otherwise
Age	age in years
Agesq	age squared
	Socio-economic variables
Edu-high	=1 if woman holds an high education degree; =0 otherwise
Edu-low	=1 if woman holds a low education degree; =0 otherwise
Edu-medium	=1 if woman holds a medium education degree; =0 otherwise
Insured	=1 if the woman is covered by private health insurance
Self-employed	=1 if the woman is self-employed; =0 otherwise
	Other controls
NW	=1 if the woman resides in a North-West region; =0 otherwise
NE	=1 if the woman resides in a North-East region; =0 otherwise
CEN	=1 if the woman resides in a Centre region; =0 otherwise
ISL	=1 if the woman resides in a Island region (Sicily or Sardinia); =0 otherwise
Area-metropol	=1 if the woman resides in a metropolitan area; =0 otherwise
Area-suburban	=1 if the woman resides in a metropolitan suburb; =0 otherwise
Area-small	=1 if the woman resides in a very small commune (less than 2000 inhabitants); =0 otherwise
Area-medium	=1 if the woman resides in a medium-small commune (between 2000 and 10000 inhabitants); =0 otherwise

Table 3. Main results

	Model 1		**Model 2**	
	Estimation results		**Estimation results**	
	private dummy	***ρ***	***private dummy***	***ρ***
	Univariate model			
Estimate	0.4342	-	0.4397	-
St. err	-0.0716	-	-0.0717	-
	Bivariate SURE model			
Estimate	-	0.2155	-	0.2176
St. err	-	-0.0371	-	-0.0371
	Recursive probit model			
Estimate	1.4120	-0.5063	1.4624	-0.5292
St. err	-0.3742	-0.1838	-0.3503	-0.1714

	Exogeneity tests		**Exogeneity tests**	
Test	statistic	p value	statistic	p value
CM	-1.9329	0.0532	-2.0743	0.0380
LM1	3.7732	0.0521	4.3489	0.0370
LM2	0.0854	0.7701	0.0987	0.7534
LM3	0.0958	0.7569	0.1100	0.7401
LM4	0.0819	0.7747	0.0823	0.7742
LR	4.7925	0.0286	5.4921	0.0191
RHO	-2.7540	0.0059	-3.0670	0.0020

Table 4
Predicted effect of hospital type dummy on probability of scheduling CS

(1) **Woman type**	(2) **Pr(priv)**	(3) **Pr(CS)**	(4) **Pr(CS|priv)**	(5) **Pr(CS|pub)**	(6) **Difference (s.e.)**
	Irrespective of primiparity (based on Model 1)				
Low risk	0.0957	0.1072	0.1767	0.0998	0.0769*** (0.0262)
High risk	0.0585	0.3208	0.4420	0.3133	0.1287** (0.0500)
	Primipara (based on Model 2)				
Low risk	0.0946	0.0928	0.1532	0.0865	0.0667** (0.0261)
High risk	0.0573	0.2926	0.4063	0.2857	0.1206** (0.0522)
	Multipara (based on Model 2)				
Low risk	0.0966	0.1276	0.2084	0.1190	0.0894*** (0.0288)
High risk	0.0587	0.3589	0.4894	0.3508	0.1386*** (0.0518)

(1)

Low risk woman is characterized by the absence of clinical risk (all the dummy variables indicating severity of the pregnancy set to zero); variables age, No. scans, BMI, newborn weight set to sample averages; medium education degree; without private insurance, not self-employed, delivering in 1996, residing in the North-East of Italy in a metropolitan area

High risk woman differs from the previous for the following risk factors: newborn weight equal to 2.5 Kg, BMI=30, suffers from gestosis

(2)

Marginal probability of referring to private hospital, conditional to the explanatory variables x. Conditioning to x is omitted from notation in all column headings.

(3)

Marginal probability of delivering with scheduled CS, conditional to the explanatory variables x.

(4)

Probability of planning c-section conditional to referring to private hospital (and to explanatory variables x), evaluated as: $pr(pl\_CS = 1 \mid priv = 1) = pr(pl\_CS = 1, priv = 1) / pr(priv = 1)$ through the appropriate bivariate and univariate normal cumulative distribution function.

(5)

Probability of planning c-section conditional to referring to public hospital (and to explanatory variables x), evaluated as: $pr(pl\_CS = 1 \mid priv = 0) = pr(pl\_CS = 1, priv = 0) / pr(priv = 0)$

(6)

The variance of the estimated difference between the two conditional probabilities has been evaluated through the Delta Method, exploiting analytical expressions of first order derivatives of the bivariate and univariate normal cumulative distribution function. The details of computation are available upon request.

APPENDIX 2

APPENDIX

Table A.1
Descriptive statistics

	Full sample		Public hospital admissions (PRIV==0)		Private hospital admissions (PRIV==1)	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Private	0.086	0.279	0.000		1.000	
Primipar	0.471	0.499	0.471	0.499	0.473	0.499
Diabetes	0.019	0.137	0.019	0.135	0.023	0.151
Gestosis	0.037	0.189	0.039	0.193	0.021	0.142
Hyperten	0.046	0.209	0.048	0.214	0.026	0.159
BMI	22.69	3.455	22.72	3.475	22.52	3.238
Newborn weigth	3.263	0.509	3.265	0.515	3.239	0.437
No. scans	5.378	2.319	5.359	2.322	5.579	2.275
Amniocen	0.238	0.426	0.232	0.422	0.305	0.461
Hospitalization	0.546	0.498	0.545	0.498	0.550	0.498
Smoked	0.240	0.427	0.239	0.427	0.248	0.432
Age	32.17	4.988	32.170	4.943	32.21	5.452
Age +36	0.249	0.432	0.244	0.429	0.305	0.461
Edu-high	0.108	0.311	0.103	0.304	0.168	0.374
Edu-medium	0.467	0.499	0.464	0.499	0.499	0.501
Edu-low	0.367	0.482	0.373	0.484	0.299	0.459
Insured	0.157	0.364	0.155	0.362	0.176	0.381
Self-employed	0.441	0.497	0.432	0.495	0.537	0.499
NW	0.176	0.381	0.185	0.388	0.085	0.279
NE	0.213	0.409	0.222	0.416	0.119	0.324
CEN	0.158	0.365	0.161	0.367	0.124	0.330
ISL	0.129	0.335	0.126	0.332	0.129	0.336
Area-metropol	0.081	0.273	0.074	0.262	0.155	0.362
Area-suburban	0.096	0.295	0.093	0.291	0.127	0.333
Area-small	0.186	0.389	0.196	0.397	0.080	0.272
Area-medium	0.286	0.452	0.288	0.453	0.266	0.443

Table A.2
Full estimation results

	Model 1			Model 2		
	Coeff.	Std.err	P-value	Coeff.	Std.err	P-value
SCHEDULED						
Private	1.4120	0.3742	0.0000	1.4624	0.3503	0.0000
Primipar				-0.1778	0.0524	0.0010
Primipar +36				0.3019	0.1065	0.0050
Diabetes	0.0055	0.1574	0.9720	0.0020	0.1597	0.9900
Hyperten	0.1513	0.1052	0.1500	0.1470	0.1052	0.1620
Gestosis	0.3123	0.1144	0.0060	0.3195	0.1150	0.0050
Smoked	0.0664	0.0500	0.1840	0.0667	0.0500	0.1830
Age +36	0.1217	0.0533	0.0230	-0.0053	0.0646	0.9340
Hospitalization	0.0264	0.0438	0.5470	0.0310	0.0438	0.4800
Newborn weight	-1.0110	0.2324	0.0000	-0.9734	0.2334	0.0000
Newborn weight sq.	0.1049	0.0360	0.0040	0.0986	0.0361	0.0060
BMI	0.0285	0.0064	0.0000	0.0275	0.0065	0.0000
Amniocen	0.0649	0.0548	0.2360	0.0598	0.0548	0.2750
No. scans	0.0405	0.0092	0.0000	0.0414	0.0092	0.0000
Edu-LOW	-0.0843	0.0965	0.3820	-0.0618	0.0970	0.5240
Edu-MEDIUM	-0.0430	0.0972	0.6590	-0.0124	0.0982	0.9000
Edu-HIGH	-0.0351	0.1168	0.7640	-0.0050	0.1176	0.9660
Insured	0.1489	0.0612	0.0150	0.1438	0.0613	0.0190
NW	-0.2202	0.0747	0.0030	-0.2067	0.0741	0.0050
NE	-0.2470	0.0714	0.0010	-0.2361	0.0706	0.0010
CEN	-0.0760	0.0714	0.2870	-0.0699	0.0707	0.3230
ISL	-0.0915	0.0719	0.2030	-0.0843	0.0718	0.2400
Year 1997	-0.0152	0.0647	0.8140	-0.0084	0.0647	0.8970
Year 1998	0.0646	0.0630	0.3050	0.0628	0.0630	0.3190
Year 1999-00	0.0802	0.0625	0.1990	0.0774	0.0624	0.2150
Constant	0.2600	0.4234	0.5390	0.2806	0.4249	0.5090
PRIVATE						
Primipar				-0.0120	0.0682	0.8600
Primipar +36				0.0215	0.1261	0.8640
Diabetes	0.1958	0.1878	0.2970	0.1988	0.1876	0.2890
Hyperten	-0.1648	0.1683	0.3270	-0.1631	0.1682	0.3320
Gestosis	-0.2018	0.1934	0.2970	-0.2038	0.1928	0.2910
Newborn weight	1.0577	0.4482	0.0180	1.0567	0.4461	0.0180
Newborn weight sq.	-0.1793	0.0697	0.0100	-0.1792	0.0695	0.0100
BMI	-0.0120	0.0088	0.1760	-0.0123	0.0088	0.1630
Amniocen	0.1260	0.0679	0.0630	0.1246	0.0681	0.0670
No. scans	0.0193	0.0112	0.0860	0.0194	0.0112	0.0840
Edu-LOW	0.2799	0.1508	0.0630	0.2814	0.1503	0.0610
Edu-MEDIUM	0.4662	0.1499	0.0020	0.4679	0.1500	0.0020
Edu-HIGH	0.6312	0.1630	0.0000	0.6334	0.1636	0.0000
Age	-0.1013	0.0475	0.0330	-0.1079	0.0478	0.0240
Age sq.	0.0015	0.0007	0.0350	0.0016	0.0007	0.0270
Insured	0.1881	0.0764	0.0140	0.1898	0.0763	0.0130
Self-employed	0.1341	0.0594	0.0240	0.1316	0.0596	0.0270
NW	-0.7040	0.0970	0.0000	-0.7024	0.0975	0.0000
NE	-0.5204	0.0895	0.0000	-0.5186	0.0895	0.0000
CEN	-0.5119	0.0895	0.0000	-0.5093	0.0898	0.0000
ISL	-0.2110	0.0838	0.0120	-0.2115	0.0837	0.0110
Area-metropol.	0.4264	0.0925	0.0000	0.4256	0.0923	0.0000
Area-suburban	0.2424	0.0934	0.0090	0.2406	0.0929	0.0100
Area-small	-0.3022	0.0955	0.0020	-0.3031	0.0952	0.0010
Area-medium	-0.0075	0.0685	0.9130	-0.0096	0.0683	0.8880
Constant	-1.3403	1.0324	0.1940	-1.2005	1.0383	0.2480
ρ	-0.5063	0.1838		-0.5292	0.1714	