The Effect of Payment Contracts on C-section Use

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Abstract

C-sections are the leading cause for hospitalization among women and contribute to rising health care costs. In this paper we quantify the effect of payment contracts (fee-for-service vs. capitation) on c-section rates, health care costs, and health outcomes post-delivery. We estimate a structural model of delivery choice and hospital demand, and a reduced-form pricing model. We find that hospitals are more likely to provide c-sections when it is reimbursed under fee-for-service. However, patients are less likely to choose hospitals covered under fee-for-service. We use our model estimates to compute market outcomes under counterfactual contract regulation and find substantial declines in the number of c-sections and improvements in health outcomes when both c-sections and vaginal deliveries are capitated.

Keywords: Delivery, Hospital demand, Health Insurance, Fee-for-service, Capitation

JEL codes: I11, I13, I18.

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1 Introduction

Several countries in Latin America, including Brazil, Colombia, and Chile, have experienced a rapid increase in the number of c-sections in the last couple of decades, a phenomenon some call the "c-section epidemic".[1] In Colombia, c-sections accounted for 61 percent of all deliveries in the statutory health system during 2013 (Ministerio de Salud, 2015). This c-section rate exceeds predictions from the World Health Organization and is well above the rate in OECD countries. C-sections are the leading cause for hospitalization among women, contribute to rising health care costs since they are more expensive than vaginal deliveries, and are more commonly associated with bad maternal health outcomes (AHRQ, 2018b,a; Rizo Gil, 2009). It is therefore of policy interest to design mechanisms that help reduce unnecessary c-sections. In this paper we focus on how the regulation of payment contracts between health insurers and hospitals impacts delivery choice, health care costs, and health outcomes after childbirth in the Colombian healthcare system.

The most common types of payment contracts between insurers and hospitals are capitation and fee-for-service (FFS). While use of capitation grew in many countries with the rise of managed care, FFS remains the dominant way in which insurers reimburse providers (Zuvekas and Cohen, 2016; Center for Studying Health System Change, 2008). These contracts generate starkly opposing incentives for insurers and providers. Under capitation, hospitals have incentives to under-provide care because they are exposed to higher financial risk (Aizer, Currie, and Moretti, 2007; Frakt and Mayes, 2012; Chami and Sweetman, 2019; Brot-Goldberg and De Vaan, 2018). Under FFS, hospitals have incentives to over-provide services because their revenues

[1] See https://www.eltiempo.com/salud/el-abuso-de-las-cesareas-en-colombia-juan-gossain-497792.

are proportional to the number of services provided (Cadena and Smith, 2022; Hennig-Schmidt, Selten, and Wiesen, 2011; Shafrin, 2010; Helmchen and Lo Sasso, 2010; Liu, Kao, and Hsieh, 2009). At the same time, different payment contracts may incentivize insurers to steer patients towards cheaper hospitals or higher-value care (Dranove, Ody, and Starc, 2021; Kuziemko, Meckel, and Rossin-Slater, 2018; Marton, Yelowitz, and Talbert, 2014).

Insurers and hospitals in Colombia negotiate payment contracts and prices separately for each health service. They first choose the payment contract - capitation or FFS - under which to reimburse each service. Then, conditional on the payment contract, they negotiate prices based on expected demand and costs. This means that, for a given insurer-hospital pair, it is possible that c-sections and vaginal deliveries are reimbursed under different contracts. It also means that for a given insurer, demand for in-network hospitals will vary across payment contracts.

After contracts are signed, unobservably sick patients may sort into more expensive hospitals or hospitals covered under FFS in equilibrium. Health risk can not be priced into the contracts ex-ante. Insurers and hospitals may therefore have incentives to influence treatment decisions and patient choices conditional on negotiated contracts. To combat this type of adverse selection, insurers can steer patients towards cheaper hospitals and hospitals can provide more expensive treatments. Asymmetric information thus generates scope for payment contracts to affect delivery choice, and for its regulation to potentially achieve the goal of reducing unnecessary c-sections.

We start by providing descriptive evidence of substantial adverse selection in hospital choice consistent with insurers' inability to price in health risk during negotiations with hospitals. We then document that hospitals are more likely to provide c-sections if they are reimbursed on a FFS basis. Variation in c-section rates across payment contracts is likewise suggestive of hospitals meaningfully responding to financial incentives in their treatment choices (hospital moral hazard). We also show that, conditional on delivery procedure, the delivery price is higher at hospitals with capitation contracts than at hospitals with FFS contracts. We explore whether this difference stems from the types of hospitals that select into each payment contract, and see that hospitals covered under capitation tend to be larger and of higher quality than those covered under FFS.

The descriptive evidence suggests that different incentives are at play for insurers and hospitals under capitation and FFS, consistent with economic intuition. To quantify the effect of such incentives under counterfactual contract regulations, we develop and estimate an equilibrium model of service prices, hospital demand, and delivery choice. In our model, insurers and hospitals first negotiate prices for vaginal delivery and c-section, taking observed payment contracts and enrollment decisions as given. Then, women choose an in-network hospital for their childbirth. Finally, hospitals choose whether to perform the childbirth by vaginal delivery or c-section.

We solve the model backwards, starting with the choice of delivery. We model the likelihood of having a c-section as a flexible function of delivery procedure prices and contracts as well as patient characteristics. Each woman takes into account the likelihood of receiving a c-section when making her hospital choice.

Hospital demand is a function of the woman's expected out-of-pocket (OOP) price, payment contracts for c-sections and vaginal deliveries, and a measure of provider inertia. Following Abaluck, Gruber, and Swanson (2018); Prager (2020), we instrument for selection of individuals into insurers by leveraging insurer inertia using a control function approach. We derive a reduced-form equation for the price of vaginal deliveries and c-sections from a Nash-in-Nash bargaining model which is a function of estimated demand.

To estimate our model, we use claims and enrollment data for all women who gave birth in the Colombian healthcare system during 2010 and 2011. These data are particularly well-suited for our analysis as they contain information on the payment contract under which each claim was reimbursed and negotiated prices. We focus on the subsample of women who had a childbirth in 2011 and who were continuously enrolled with the same insurer across both years.

Estimation of our delivery choice model shows that, conditional on the woman's health status, hospitals are more likely to perform c-sections the higher is the c-section price and the lower is the vaginal delivery price. The decision of which type of delivery to perform also varies significantly with the payment contract these delivery procedures are covered under, hospitals being 5 p.p. more likely to offer a c-section if it is reimbursed under FFS.

Our demand estimates show that women are approximately 38 percent less likely to choose a hospital if the expected OOP delivery price increases by $10. All else equal, hospital demand is 62 percent lower if the expected payment contract under which the delivery is covered is FFS. The negative effect of payment contracts on hospital demand conditional on price is consistent with insurers steering patients towards hospitals where delivery is capitated and the insurer's marginal cost is zero.

We estimate four pricing functions, one for FFS and one for capitation, for each delivery procedure. Results of our FFS reduced-form pricing model show that hospital markups are greater for c-sections that for vaginal deliveries. FFS prices are a decreasing function of average capitation transfers. We find substantial dispersion in FFS markups across hospitals, which is suggestive of differences in bargaining power relative to insurers. Under a FFS contract, we predict that the marginal cost of a c-section equals $264, while the marginal cost of a vaginal delivery equals $242. Predictions of our capitation pricing function also show that the base capitated transfer is $311 for a c-section and $187 for vaginal deliveries.

We use our equilibrium model of delivery choice and hospital demand to simulate the expected number of c-sections, delivery costs, and health outcomes under alternative payment contracts. Given that contracts arise endogenously as a result of insurer and hospital competition, which we do not model, we think of these counterfactuals as government mandates over which services can be covered under each payment contract.

We find that moving to a fully capitated system, where both c-sections and vaginal deliveries are covered under capitation for every insurer-hospital pair, results in a 7 percent decrease in the expected number of c-sections per hospital and a 13 percent increase in delivery costs per hospital. We find that reductions in the number of c-sections stem from low-risk pregnancies. Our results also suggest that maternal health outcomes improve with full capitation. Therefore, prospective payment structures reduce usage of medically unnecessary c-sections.

This paper contributes to the literature on payment contracts between insurers and hospitals. Perhaps the paper that is most similar to ours is Ho and Pakes (2014). The authors analyze referral decisions made by physician groups whose compensation is capitated. We complement their work by focusing on the interplay of contracts with hospital and procedure choice in the presence of negotiated prices. Our paper is also related to Acquatella (2022a,b) in considering the effects of contracts on realized health care costs and providers' treatment decisions.

Our counterfactual results speak to the potential of different payment contracts to influence the type and cost of health care. These outcomes are important and topical in the context of childbirth for several reasons. First, c-section rates have been shown to vary considerably across hospitals without correlation with infant outcomes (Kozhimannil, Law, and Virnig, 2013; Baiker, Buckles, and Chandra, 2006; VanGompel, Perez, Datta, Wang, Cape, and Main, 2019). Second, c-sections among low-risk mothers or unnecessary c-sections contribute to rising healthcare costs (Podulka and Steiner, 2011; Sakala, Delbanco, and Miller, 2013; Teleki, 2020). Third, there is recent policy interest and policy efforts aimed at reducing c-section rates (see e.g, California Health Care Foundation, 2022; Rosenstein, S., Sakowski, Markow, Teleki, Lang, Logan, Cape, and Main, 2021).

The remainder of this paper is structured as follows. Section 2 provides a description of the Colombian healthcare system. Section 3 introduces our data. Section 4 provides a descriptive analysis. Section 5 presents our equilibrium model of hospital demand. Section 6 discusses parameter identification. Section 7 presents our estimation results. Section 8 provides our policy counterfactual results. Section 9 concludes.

2 Background

Colombia's statutory healthcare system is divided into a contributory regime and a subsidized regime. The contributory regime covers the 51 percent of the population that are above a monthly income threshold and are able to pay the required tax contributions to the system. The remaining 49 percent of the population who are below the income threshold are covered by the subsidized regime, which is fully funded by the government. The healthcare system has nearly universal coverage and provides access to a national health insurance plan through private insurers.

The national plan covered a comprehensive list of more than 7 thousand services and procedures and more 700 prescription medications as of 2011. Cost-sharing rules are specified by the government based on the enrollee's monthly income level. Individuals are grouped according to whether they make less than two times the monthly minimum wage (MMW), between two and five times the MMW, or more than five times the MMW. Coinsurance rates, copays, and maximum out-of-pocket expenditures within each group are set by the government, increase monotonically across income brackets, and are standardized across insurers and hospitals.

In addition to regulating cost-sharing rules, the government sets insurance premiums to zero. Private insurers instead receive two types of transfers from the government. At the beginning of each year, the government makes per-enrollee transfers that are risk-adjusted for the enrollee's sex, age, and municipality of residence. At the end of every year, the government also compensates insurers for a non-exhaustive list of diseases. Insurers with a below-average share of patients with diseases in this list make payments to those with an above-average share. Both risk adjustment mechanisms are insufficient to control risk selection incentives in this healthcare system (Serna, 2022; Riascos and Camelo, 2017; Riascos, 2013).

Insurers have discretion over which hospitals to cover for each service in the national plan. Insurers bargain over prices and payment contracts for each service with the hospitals in their network. The government allows insurers and hospitals to choose from among the following set of payment contracts to negotiate their terms: fee-for-service, capitation, fee-for-package, and fee-for-diagnosis. The most common payment contracts under which services are reimbursed in our data are capitation and FFS. Almost 51 percent of all claims filed during 2011 were reimbursed on a capitated basis and another 43 percent on a FFS basis.

When a service is reimbursed under a FFS contract, the insurer and the hospital will have negotiated a price that is paid by the insurer each time the service is provided. For example, if the negotiated FFS price of a primary care visit is \$10 and the price of a blood test is \$20, then the insurer of a patient who visits the primary care physician and receives two blood tests will pay \$50 to the hospital that provided those services. Payments under FFS contracts are thus retrospective, and hospital revenue is proportional to the number of services provided. This payment contract incentivizes hospitals to over-provide services, or to provide relatively more expensive services. Insurers bear the financial risk of this over-provision of care. Insurers may therefore have incentives to steer patients away from hospitals with a high share of services reimbursed on a FFS basis.

Under a capitation contract, insurers and hospitals bargain over a per-enrollee price that covers the provision of all capitated services. This per-enrollee price is paid once in every contracting period (typically a calendar year) and does not vary with the number of capitated services provided. For example, if primary care visits and blood tests are both capitated and the payment for capitated services is $30, then insurer of the patient from our previous example pays $30 to the hospital regardless of whether the patient claims those services, or how many they claim.[2]

3 Data

To study hospital choice and health care costs under different payment contracts, we use enrollment and claims data for all individuals enrolled in the Colombian contributory regime in 2010 and 2011. Our data are comprised of 187,389 unique women who have a first childbirth in 2011 at a hospital that performs at least 10 childbirths. Our analysis uses the subsample of women who do not switch to the subsidized system nor switch their insurer from 2010 to 2011 (N=135,791). Further sample restrictions, such as dropping hospitals that perform only one type of delivery and dropping women with missing values in their observed characteristics, reduce the number of observations for our analysis sample to 109,821.

[2] Hospitals and insurers in our setting do not negotiate "shared risk agreements" wherein costs over and above the capitation payment are split between the insurer and the hospital. In this sense, capitation contracts in our setting are global.

In the claims data, we observe the date on which each claim was provided, the provider that rendered the claim, the insurer that reimbursed it, and the associated ICD-10 diagnosis code. We have basic demographic information such as age, income group, and municipality of residence. Using this information we can recover each enrollee's level of cost sharing and the risk adjustment payments that the government would have made to insurers for each of their enrollees.

We create patient-level diagnosis indicators by grouping ICD-10 codes recorded before the delivery date according to the methodology in Riascos, Alfonso, and Romero (2014) and classify women as having either high- or low-risk pregnancies.[3] We do not observe the woman's residence address to measure distance to each hospital.

Importantly, we observe whether each claim was reimbursed under a FFS or a capitation contract and its price. We consider claims reimbursed under fee-for-package and fee-for-diagnosis to be forms of capitation as well.[4] In the case of FFS, the reported price is the negotiated price for that service. Patients' OOP costs for services covered under FFS equals the product of their coinsurance rate and this reported price. For capitated claims, the reported price is the unit price of the service in the set of capitated services. Patients' OOP costs in this case also equals the product of their coinsurance rate and this reported unit price. For each payment contract, we consider reported prices to be the outcomes of insurer and hospital and negotiations. In our pricing model in section 5, we assume that insurers and hospitals bargain over

[3] Women with high-risk pregnancies are those who receive an ICD-10 diagnosis code of O09, V23, O10-O16, O20-O29, and O25, related to supervision of high-risk pregnancy; edema, proteinuria, and hypertensive disorders in pregnancy, childbirth, and the puerperium; other maternal disorders predominantly related to pregnancy; and malnutrition in pregnancy. Low-risk pregnancy women are the rest.

[4] Fee-for-diagnosis and fee-for-package make up less than 6 percent of claims. Fee-for-diagnosis payments are per-enrollee payments made only for patients with specific health conditions; e.g. a fixed payment for diabetes will be made by the insurer for all diabetic patients. Fee-for-package payments are per-enrollee payments made only for patients that have specific healthcare episodes; e.g. a fixed payment for childbirth will be made by the insurer for all patients who are pregnant.

these FFS and unit capitation prices.

Because reported prices may differ from negotiated prices based on encounter characteristics that are unobserved at the time of negotiations, we obtain negotiated prices for vaginal deliveries and c-sections in the style of Gowrisankaran, Nevo, and Town (2015).[5] Negotiated prices are the average predictions of linear regressions of reported prices on patient characteristics and hospital fixed effects, estimated separately for each insurer and type of delivery. Averages are taken across delivery claims within a hospital-insurer-contract triplet. We describe this procedure in more detail in Appendix A. We refer to the predictions obtained from this methodology as "prices" from now on.

We recover each insurer's network of delivery hospitals in each market from observed claims. We are able to build patients' choice sets this way as all claims in our data correspond to in-network providers, and since we focus on providers with at least 10 claims for delivery procedures. We define a market as a municipality. There are 1,123 municipalities in Colombia. Municipalities are smaller geographical units than Colombian states. We assume that women have their baby delivered at a hospital covered by their insurer in their municipality of residence. In practice, women typically do not travel far to receive obstetric care, and patients, especially those in labor, tend to visit nearby providers (Minion, Krans, Brooks, Mendez, and Haggerty, 2022; AHRQ, 2018c). In the claims data we do not observe the individual obstetrician at each hospital that performs deliveries. Our model therefore assumes that doctors are perfect agents for the hospital or that doctors' and hospitals' incentives are perfectly aligned.

Summary statistics for our sample are provided in table 1. An observation in

[5] Reported prices may differ from negotiated prices along the patient's length-of-stay, for example. Length-of-stay for each patient is observed only after the patient makes a claim.

Table 1: Summary statistics

		All (1)	Vaginal (2)	C-section (3)
Contracts	Price	276 (135.5)	261 (134.6)	293 (134.6)
	FFS	0.78 (0.41)	0.75 (0.43)	0.81 (0.39)
	C-section	0.50 (0.50)	—	—
Demographics	Age 18-24	0.28 (0.45)	0.31 (0.46)	0.24 (0.43)
	Age 25-29	0.31 (0.46)	0.32 (0.47)	0.30 (0.46)
	Age 30-34	0.25 (0.44)	0.24 (0.43)	0.27 (0.44)
	Age 35 or more	0.15 (0.36)	0.13 (0.33)	0.18 (0.38)
	Low income	0.77 (0.42)	0.77 (0.42)	0.78 (0.42)
	Medium income	0.19 (0.39)	0.19 (0.39)	0.19 (0.39)
	High income	0.04 (0.19)	0.04 (0.20)	0.03 (0.18)
	Urban municipality	0.51 (0.50)	0.58 (0.49)	0.44 (0.50)
	Rural municipality	0.49 (0.50)	0.42 (0.49)	0.56 (0.50)
Health	Cancer	0.05 (0.22)	0.04 (0.21)	0.06 (0.23)
	Cardiovascular	0.02 (0.15)	0.02 (0.13)	0.03 (0.17)
	Diabetes	0.00 (0.06)	0.00 (0.05)	0.00 (0.06)
	Cost up to delivery	378 (562.3)	332 (421.0)	419 (670.9)
	High-risk pregnancy	0.15 (0.36)	0.14 (0.34)	0.17 (0.37)
	Bad health outcome	0.15 (0.16)	0.14 (0.16)	0.15 (0.16)
	Maternal mortality	0.03 (0.10)	0.03 (0.10)	0.03 (0.11)
Providers		429	411	418
Insurers		14	14	14
N		109,821	54,680	55,141

Note: Table shows mean and standard deviation in parentheses of main variables in the full sample of deliveries in column (1), conditional on vaginal deliveries in column (2), and conditional on c-sections in column (3). Prices and costs are measured in dollars.

this table is a delivery. Column (1) uses the full sample of deliveries, column (2) conditions on vaginal deliveries, and column (3) conditions on c-sections. The full sample contains 429 unique providers and 14 unique insurers. The average price of a delivery in column (1) is \$276. C-sections are on average \$32 more expensive than vaginal deliveries. 81 percent of c-sections and 75 percent of vaginal deliveries are covered under FFS.

Women who receive a c-section are on average older and in worse health than those who receive a vaginal delivery. The rates of comorbidities including cancer, cardiovascular disease, and diabetes are all higher among women who receive c-sections. C-sections are also more common than vaginal deliveries among high-risk pregnancies. Differences in health status across chosen delivery procedure are also reflected in differences in total health care costs up to but not including the delivery: women who receive c-sections are on average \$87 more expensive than women who receive vaginal deliveries before the time of delivery.

We construct two measures of hospital quality: the rates of bad health outcomes and maternal mortality.[6] There is little evidence of quality differences across hospitals according to the type of delivery. We see no difference in the hospital rate of bad post-delivery health outcomes in the three months following childbirth across delivery type. We also see no difference in hospital-level maternal mortality.

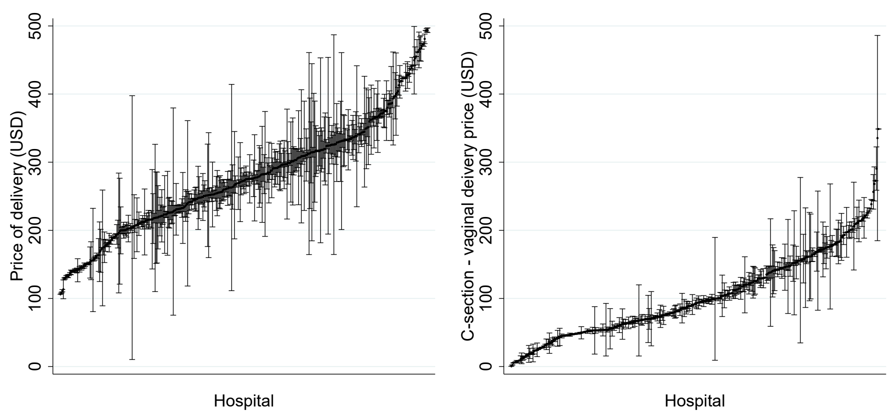
Our goal is to quantify how changes in payment contracts affect hospital and procedure choice, and how these choices vary with health status. The following section describes the sources of variation in our data that will allow us to quantify these effects.

[6]The variable "Bad health outcome" is an indicator variable for hospitals were women have a hospitalization, hemorrhage (ICD10 code R85), puerperal sepsis (ICD10 code O85), or infection of obstetric surgical wound (ICD10 code O86), three months after childbirth. Mortality data come from the National Administrative Department of Statistics.

4 Descriptive analysis

In this section, we present descriptive evidence of how payment contracts correlate with market outcomes. Despite being very common procedures, prices for deliveries in our data vary significantly across and within hospitals. Figure 1 summarizes each of these sources of variation. The left hand figure presents the mean and 95 percent confidence interval of delivery prices for each hospital in the horizontal axis. The right hand panel presents the same statistics for the difference between the price of a c-section and the price of a vaginal delivery. We use this price variation within hospital to identify the parameters of our demand model in section 5. The average price of a delivery ranges from \$106 and \$493. The average standard deviation of delivery prices within a hospital is \$67. C-sections are on average \$104 more expensive than vaginal deliveries.

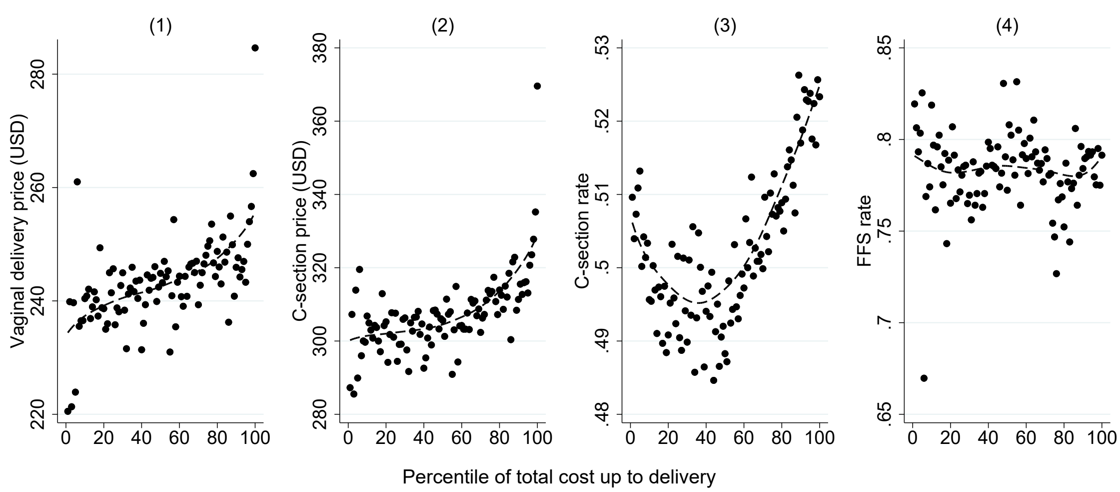
Figure 1: Variation in Delivery Prices



Note: Figure shows the average and 95 percent confidence interval of delivery prices in the left panel and the difference between c-section and vaginal delivery prices in the right panel. An observation on the horizontal axis is a hospital. Hospital are arranged in ascending order of delivery prices or their difference.

The fact that there is substantial variation in delivery prices within hospitals may be the result of differences in bargaining power relative to insurers or of adverse selection in hospital demand. If patients non-randomly sort into hospitals, then we should see a correlation between underlying patient health and hospital prices. In figure 2, we stratify patients into percentiles of health care costs up but not including the delivery, which we use as proxy for the woman's underlying health status. The left two panels of figure 2 show the correlation between hospital delivery prices and this measure of underlying health status. We see that women who are costlier prior to childbirth choose more expensive hospitals for delivery. Not only are prices higher at the hospitals chosen by costlier women, but so is the hospital c-section rate as seen in the third panel of figure 2. This suggests that costlier patients tend to prefer hospitals with higher treatment intensity. To the extent that health care costs are a good proxy for underlying health status, these results are reflective of adverse selection in delivery hospital choice. We will capture this in our hospital demand model by allowing women's preferences over hospital characteristics to vary according to their demographics and diagnoses.

FIGURE 2: Patient sorting on prices, c-section rates, and contract types



Note: Figure shows the average of vaginal delivery prices (panel 1), c-section prices (panel 2), c-section rate (panel 3), and FFS rate (panel 4) across delivery hospitals chosen by patients in the percentile of costs up to the time of delivery indicated on the horizontal axis.

While costlier patients tend to sort into hospitals with higher priced procedures, there is no evidence of patient sorting into hospitals according to payment contracts. The far right panel of figure 2 shows the correlation between the hospital FFS rate and percentiles of health care costs up to the time of delivery. We see no correlation between the FFS rate and our measure of underlying health status. This may be because payment contracts are not observable to patients when making their enrollment, hospital, or delivery choices. Payment contracts also only influence patients' OOP costs through negotiated prices, hence patients are unlikely to sort on contracts directly. Patient demand may respond to payment contracts based on their effect on prices or through insurer steering incentives. Our model will allow for contracts to affect hospital choice along both of these dimensions.

TABLE 2: Variation in c-section rates across patients and contracts

	Capitation	FFS
Age<30, Healthy	0.41	0.48
Age<30, Unhealthy	0.49	0.53
Age>=30, Healthy	0.51	0.55
Age>=30, Unhealthy	0.55	0.64

Note: Table shows mean and standard deviation in parenthesis of c-section rate conditional on the woman's observable characteristics (age and having a chronic disease) and whether c-sections are covered under FFS.

The previous descriptives showed variation in responsiveness to negotiated prices across patients consistent with adverse selection. We now turn to examining variation in hospitals' delivery choice generated by payment contracts. Table 2 reports c-section rates by type of woman and payment contract. Women are categorized based on age and on whether they have a chronic disease diagnosis. Consistent with previous literature (e.g., Currie and MacLeod, 2017), the table shows that conditional on the payment contract, c-sections are more common among older, sicker women than among young, healthy women. The table also shows that conditional on the type of woman, c-sections are more common when they are reimbursed on a FFS basis. Covariation between payment contracts and treatment choice is suggestive of hospital moral hazard.

Table 3 reports the average delivery price conditional on the woman's observable characteristics and on whether the procedure is covered under FFS. We see that conditional on payment contract, c-sections are more expensive than vaginal deliveries. This pattern is consistent with the price differential reported in figure 1 and with the fact that these procedures are typically covered under the same payment contract for a given insurer-hospital pair. Conditional on the type of delivery, capitation prices are higher than FFS prices. This pattern may be the result of (i) insurers anticipating hospital moral hazard when negotiating prices with hospitals, (ii) hospitals anticipating their increased financial risk under capitation, (iii) hospitals under capitation having greater dispersion in patient health risk in the lines of Acquatella (2022b).

Table 3: Variation in price across patients and contracts

	C-section		Vaginal	
	Capitation	FFS	Capitation	FFS
Age<30, Healthy	427.7	274.5	379.5	202.9
Age<30, Unhealthy	430.1	280.5	374.6	207.2
Age>=30, Healthy	398.8	284.7	358.0	213.5
Age>=30, Unhealthy	421.6	281.1	373.8	205.6

Note: Table shows mean of delivery price conditional on the woman's observable characteristics (age and having a chronic disease) and on whether the procedure is covered under FFS.

Which hospitals negotiate which contracts? Price variation across payment contracts conditional on procedure raises questions about selection of hospitals into payment contracts. While we do not explicitly model how these contracts emerge in equilibrium, knowing which type of hospitals negotiate which contracts is important for understanding the welfare implications of counterfactual contract regulation.

Table 4 presents average characteristics of hospitals that negotiate capitation and FFS for vaginal deliveries and c-sections. For both procedures, we see that hospitals that negotiate capitation contracts are significantly larger and of relatively higher quality than those that negotiate FFS contracts. Hospitals under capitation have approximately 10 more beds and two more obstetric rooms than those under FFS. Hospitals under capitation also have lower rates of bad maternal health outcomes post-delivery and a slightly lower maternal mortality rates. The correlation between size and payment contracts may be reflective of larger hospitals being better able to pool risks across patients or treating a more heterogeneous patient mix compared to smaller hospitals.

TABLE 4: Average hospital characteristics by payment contract

	Vaginal delivery		C-section	
	Capitation	FFS	Capitation	FFS
Beds	168.1	149.6	165.8	151.0
Rooms	8.19	6.56	8.05	6.67
Private	0.97	0.88	0.97	0.89
Any ambulance	0.03	0.29	0.03	0.28
Maternal mortality	0.03	0.04	0.02	0.05
Bad outcome	0.18	0.21	0.18	0.21

Note: Table shows average hospital characteristics across deliveries by type of payment contract for vaginal deliveries and c-sections.

5 Model

To study the impact of payment contracts on c-section rates and delivery costs, we develop a model of hospital and delivery choice. Throughout the model we take observed payment contracts and hospital networks as given. The timing is as follows.

1. Insurers and hospitals negotiate delivery prices, conditional on contracts.

2. After observing prices, women choose a hospital in the network of their insurer at which to have a childbirth.

3. Observing prices and payment contracts, the patient and hospital jointly decide whether to deliver the child by vaginal delivery or c-section.

In this setup, we abstract from the choice of insurer, which is typically modelled between stages 1 and 2. This implies that we need to correct for selection into insurers when estimating stage 2; we expand on this in section 6. We lay out our model starting from the choice of delivery procedure.

5.1 Delivery choice

Let d_{ijh} be an indicator for whether a woman enrolled with insurer j receives a c-section at in-network hospital h. Also let p_{jh} be the negotiated price of a c-section, and q_{jh} the negotiated price of a vaginal delivery between insurer j and hospital h. Moreover, let f_{jh} be an indicator for whether c-sections are covered under FFS, and g_{jh} an indicator for whether vaginal deliveries are covered under FFS. We assume doctors are perfect agents for hospitals and observe procedure prices and payment contracts. We model the probability of a c-section as a linear function of negotiated prices and contracts:

$$d_{ijh} = \theta_1 p_{jh} + \theta_2 q_{jh} + \theta_3 f_{jh} + x_i' f_{jh} \theta_4 + x_i' \theta_5 + \varphi_j + \delta_{t(h)} + \varepsilon_{ijh}$$

Here, x_i is a vector of the woman's observable characteristics including indicators for age group, having a chronic disease, being a high-risk pregnancy, day of delivery, and municipality of residence. The coefficients φ_j are insurer fixed effects and $\delta_{t(h)}$ are municipality fixed effects. The predicted likelihood of a c-section is

$$\hat{\phi}_{ijh} = \hat{E}[d_{ijh} | p_{jh}, q_{jh}, f_{jh}, x_i; \hat{\theta}]$$

The responsiveness of c-section choice to financial characteristics conditional on patient characteristics, measured by θ_1 through θ_4, captures hospital moral hazard. The literature that studies provider moral hazard typically models physicians as altruistic agents that make treatment decisions taking into account their patient's utility (e.g, Godager and Wiesen, 2013). Providers may weigh patient's OOP costs against their own reimbursements when responding to financial characteristics. A relatively higher weight on own reimbursements would bias providers in favor of the procedure with the higher markup. By including negotiated prices rather than OOP costs and hospital reimbursements separately, our estimates represent the net effect of provider altruism and moral hazard. Because providers may be less responsive to payment contracts among high-risk women, we interact the FFS indicator for c-sections with patient characteristics.

5.2 Hospital demand

We model a woman's choice over in-network delivery hospitals as a function of her expected OOP price, procedure contracts, and an indicator for past visits to the hospital. The expectation of OOP price is taken over the type of delivery. The probability distribution over types of delivery is endogenous and comes from our model of delivery choice. In particular, define the expected delivery price $\hat{p}_{jh}$ as:

$$\hat{p}_{ijh} = \hat{\phi}_{ijh} p_{jh} + (1 - \hat{\phi}_{ijh}) q_{jh}$$

and the expected payment contract as

$$\hat{f}_{ijh} = \hat{\phi}_{ijh} f_{jh} + (1 - \hat{\phi}_{ijh}) g_{jh}$$

Pregnant woman i enrolled with insurer j has the following utility from choosing hospital h for delivery:

$$u_{ijh} = \alpha_i c_i \hat{p}_{ijh} + \lambda_j \hat{f}_{ijh} + \gamma_i \hat{\phi}_{ijh} + \delta_i y_i + x'_{ih}\beta + \eta_h + \varepsilon_{ijh} \quad (1)$$

where $\alpha_i = x'_i\alpha$, $\delta_i = x'_i\delta$, $\lambda_j = z_j\lambda$, and $\gamma_i = x'_i\gamma$. The variable c_i is the patient's coinsurance rate, and y_i is an indicator for whether the woman went to hospital h in the year prior to her childbirth for health care that may be unrelated to obstetric care. We include a vector x'_{ih} of observable hospital characteristics interacted with patient characteristics. We also include a hospital fixed effect η_h to capture hospital quality. We normalize the fixed effect for the largest hospital (in terms of the number of women who choose it) in each choice set to zero following Ho and Pakes (2014). ε_{ijh} is a preference shock assumed to follow a type-I extreme value distribution.

The first term on the right side of equation (1) is the patient's expected OOP price. Contracts affect this payment both through their effect on the type of delivery provided and on delivery prices. Observed heterogeneity across women in their sensitivity to OOP prices is captured through interactions of α with x_i, which includes indicators for age group, having a chronic disease, having a high-risk pregnancy, and zone of residence (urban or rural).

The second term in equation (1) captures differences in demand across hospitals reimbursed on a FFS basis relative to those reimbursed on a capitated basis. Since capitation payments are sunk, the marginal cost of deliveries at capitated hospitals is zero from the perspective of the insurer, which may motivate them to steer patients toward capitated hospitals. We interact λ with an indicator for whether the woman was enrolled with any of three largest insurers in the country, z_j. This interaction captures the possibility that large insurers may be better able to steer their patients.

In the third term, we include the probability of receiving a c-section, $\hat{\phi}_{ijh}$, directly in the utility function to capture women's preferences for each procedure as in Currie and MacLeod (2017).

The fourth term in equation (1) captures provider inertia. There is substantial evidence in the literature that patients are more likely to choose a hospital or a provider if they have had previous healthcare encounters at it (Drake, Ryan, and Dowd, 2022; Saltzman, Swanson, and Polsky, 2022).[7] Inclusion of past choices in the utility function helps correct for the potential bias in price sensitivity arising from provider inertia. For example, if women visited cheap hospitals and continue to do so because of inertia, then our model would interpret women as having an aversion to expensive hospitals.

Lastly, we include interactions between hospital and patient characteristics, x_{ih}, to represent preference heterogeneity over number of beds as well as the hospital's rate of negative post-delivery outcomes and rate of maternal mortality. This source of preference heterogeneity is important to account for the fact that sicker patients may have stronger preferences for larger or higher-quality hospitals.

Given the distribution of the preference shock, woman i's likelihood of choosing hospital h is

$$s_{ijh}(f_{jh}, g_{jh}, \cdot) = \frac{\exp(\psi_{ijh})}{\sum_{k \in H_j} \exp(\psi_{ijk})}$$

where $\psi_{ijh} = \alpha_i c_i \hat{p}_{ijh} + \lambda_j \hat{f}_{ijh} + \gamma_i \hat{\phi}_{ijh} + \delta_i y_i + x'_{ih}\beta + \eta_h$ and H_j is the set of hospitals in insurer j's network.

Following McFadden (1996), the woman's (dollarized) expected utility for insurer

[7] While we cannot distinguish between state dependence and unobserved changes in preferences as the cause of provider inertia, this distinction is not needed for the purposes of conducting counterfactual analyses.

j's network is

$$W_{ij}(f_{jh}, g_{jh}, \cdot) = \frac{1}{-\alpha_i} \log \left(\sum_{h \in H_j} \exp(\psi_{ijh}) \right)$$

We use this expected utility in our derivation of a procedure pricing function in the next subsection.

Why do payment contracts affect demand? Although contracts are not observed by patients either when making their enrollment decisions or when making hospital choices, there are several reasons to believe that they influence hospital demand directly. First, hospitals reimbursed under FFS have an incentive to increase patient volume, as their profits are proportional to the number of deliveries provided. Second, the type of payment contract that insurers and hospitals negotiate may be correlated with unobserved hospital quality. Third, patients may face choice frictions that induce correlation between the types of hospitals they choose and the payment contracts those hospitals negotiate. Fourth, insurers have incentives to steer patients away from hospitals reimbursed on a FFS basis toward those where delivery procedures are capitated. The inclusion of the expected payment contract may capture any of the effects listed above, but cannot distinguish between them.

5.3 Pricing functions

Denote by $s_{jh}(f_{jh}, g_{jh}, \cdot) = \sum_i s_{ijh}(f_{jh}, g_{jh}, \cdot)$ the demand for hospital h in the network of insurer j. In Appendix B, we derive a reduced-form expression for FFS prices and unit capitation prices from a model of Nash-in-Nash bargaining between insurers and hospitals. Our reduced-form expression of the FFS pricing function for c-sections is

$$p^1_{jh} = \underbrace{\mu^1_j + \mu^1_{t(h)}}_{\text{Marginal cost}} - \underbrace{\left(\frac{\partial s_{jh}}{\partial p^1_{jh}} + \sum_{k \in F_j} \left(\frac{\partial W_j}{\partial p^1_{jh}} - \frac{\partial TC_j}{\partial p^1_{jh}} \right) s_{jk} \right)^{-1} \left(\omega^1 s_{jh} + \tau^1 \overline{p}^0_j \right)}_{\text{Markup}} + \epsilon^1_{jh} \qquad (2)$$

and the reduced-form expression of the c-section capitation price is

$$p_{jh}^0 = \underbrace{-\tau^0\Big(\frac{\partial W_j}{\partial p_{jh}^0} - \frac{\partial TC_j}{\partial p_{jh}^0}\Big)^{-1}\Big(\frac{\partial s_{jh}}{\partial p_{jh}^0}p_{jh}^1\Big)}_{\text{Markup}} \tag{3}$$

$$\underbrace{-\omega^0\Big(\frac{\partial W_j}{\partial p_{jh}^0} - \frac{\partial TC_j}{\partial p_{jh}^0}\Big)^{-1} s_{jh}\overline{p}_j^1 + \kappa^0\frac{\overline{p}_j^1}{\hat{\sigma}_j} + \mu_j^0 + \mu_{t(h)}^0}_{\text{Base transfer}} + \epsilon_{jh}^0$$

Analogous expressions can be written for vaginal deliveries with FFS prices and unit capitation prices given by q_{jh}^1 and q_{jh}^0, respectively. In these equations, $\hat{\sigma}_j$ is insurer j's *fixed* market share in the number of pregnant women, μ_j is an insurer fixed effect, and $\mu_{t(h)}$ is a municipality fixed effect. κ, ω, and τ are parameters to be estimated. The dollarized value of insurer j's network, $W_j(f_{jh}, g_{jh}, \cdot) = \sum_i W_{ij}(f_{jh}, g_{jh}, \cdot)$, is our measure of insurer revenues. Insurer j's total cost is given by $TC_j = \sum_{h\in F_j}\sum_i(1-c_i)p_{jh}^1 s_{ijh}(p_{jh}^1, p_{jh}^0) + \sum_{h\in K_j} p_{jh}^0\sigma_j(p_{jh}^1, p_{jh}^0)$, where F_j is the set of hospitals covered under FFS and K_j is the set of hospitals covered under capitation.

In our framework where insurers and hospitals negotiate prices conditional on payment contracts, the insurer's disagreement payoff is not the profit it would enjoy by dropping the hospital from the network, as is usual in the health literature that uses Nash-in-Nash. We instead define the insurer's disagreement payoff when negotiating FFS prices as the profits it would enjoy by capitating the hospital but keeping it in the network. Similarly for a capitation contract, the insurer's disagreement payoff is the profits it would enjoy from covering the hospital under FFS.

The first two terms on the right side of equation (2) capture the fixed marginal cost of providing a c-section. The third term is our reduced-form approximation to hospital markups under FFS. The FFS markup is a function of hospital demand s_{jh}, average capitation transfers $\overline{p}_j^0$, derivatives of hospital demand $\frac{\partial s_{jh}}{\partial p_{jh}^1}$, and derivatives of insurer profits approximated by $\frac{\partial W_j}{\partial p^1_{jh}} - \frac{\partial TC_j}{\partial p^1_{jh}}$. Finally, ϵ^1_{jh} is our FFS structural unobservable.

The second line of equation (3) represents the minimum capitated transfer. The first line is our approximation to markups in a capitation contract. The markup is a function of hospital demand s_{jh}, average FFS prices $\overline{p}^1_j$, derivatives of hospital demand $\frac{\partial s_{jh}}{\partial p^0_{jh}}$, and derivatives of insurer profits $\frac{\partial W_j}{\partial p^0_{jh}} - \frac{\partial TC_j}{\partial p^0_{jh}}$. The capitation structural unobservable is given by ϵ^0_{jh}.

6 Identification and estimation

Delivery choice. Our delivery choice model includes insurer and municipality fixed effects. This implies that to identify the parameters θ, we rely on variation in prices and payment contracts across the hospitals in an insurer's network in a given market. This type of variation is likely correlated with unobserved hospital quality or the patient's unobserved health status. For example, if unobservably high-risk women who need c-sections are more likely to visit higher priced hospitals, then our estimates of responsiveness to prices will be biased upwards. To correct for this type of endogeneity, we instrument prices and payment contracts with their lagged values, average prices in other markets, and hospital characteristics that are reflective of hospital quality. We estimate the delivery choice function using OLS.

Hospital demand. Enrollee's choice of insurer is one source of selection bias that threatens identification of our demand model. An enrollee may choose her insurer because it has negotiated low delivery prices with her preferred hospitals. This correlation would bias our estimate of price sensitivity to zero. We follow Prager (2020) and Abaluck et al. (2018) and correct for this source of selection bias by leveraging inertia in insurer choice. Our main estimation sample is the set of enrollees who were enrolled with the same insurer between 2010 and 2011. Assuming that inertia plays a major role in the decision (or lack thereof) to switch insurers in this setting, the sorting of patients into prices and payment contracts after the period of initial choice will be quasi-random.[8]

Our preferred demand estimation procedure is one that uses a control function for the woman's OOP price following Petrin and Train (2010). In the first stage, we regress the woman's OOP price on patient characteristics, hospital fixed effects, and an instrument, c-section and vaginal delivery prices in other markets. In the second stage, we estimate our demand model, including the residuals from the first-stage interacted with patient observables as covariates.[9]

The coefficient on the OOP price, α_i, is identified from price variation across the hospitals that insurers include in their network. We also use variation in choice sets across patients in the same cost-sharing tier who are enrolled with different insurers or located in different markets. In addition to these sources of price variation, we leverage variation in the fraction of women who reach their OOP maximum. The coinsurance rate for these women is zero, which generates variation in the OOP price among women enrolled to the same insurer and located in the same market. The coefficient on the expected payment contract, λ_j, is identified from variation in negotiated contracts across hospitals in an insurer's network as well as from variation

[8] Inertia has been shown to be a major determinant of health care consumption decisions settings beyond insurer choice. See for example, Polyakova (2016); Handel (2013).

[9] More formally, in the first stage we estimate the following linear regression:

$$c_i \hat{p}_{jh} = \tau_1 p'_{jh} + \tau_2 q'_{jh} + \tau_3 \hat{f}_{jh} + \tau_4 \hat{\phi}_{ijh} + \tau_5 y_i + x'_i \beta + \eta_h + \nu_{ijh}$$

where p'_{jh} and q'_{jh} denote the prices in other markets for c-sections and vaginal deliveries, respectively. From this regression, we obtain the residuals $\hat{\nu}_{ijh}$. Under the assumption that $E[\hat{\nu}_{ijh} \varepsilon_{ijh}] \neq 0$ and that $E[c_i \hat{p}_{jh} \varepsilon_{ijh} | \hat{\nu}_{ijh}] = 0$, we incorporate these residuals into demand estimation as:

$$u_{ijh} = \alpha_i c_i \hat{p}_{jh} + \lambda_j \hat{f}_{jh} + \gamma_i \hat{\phi}_{ijh} + \delta_i y_i + x'_{ih} \beta + \eta_h + \rho x'_i \hat{\nu}_{ijh} + \varepsilon_{ijh}.$$

Estimation is by maximum likelihood using a conditional logit.

in the likelihood of receiving a c-section, $\hat{\phi}_{ijh}$.

Finally, the coefficient on provider inertia, γ_i, is identified from variation in whether women have their childbirth at the same hospitals they visited in 2010 for health care that may be unrelated to their pregnancy. The demand model in equation (1) is a conditional logit, which we estimate by maximum likelihood. We compute standard errors with 100 bootstrap resamples.

Pricing functions. Our pricing functions are reduced-form representations of the equilibrium prices that would result from bilateral bargains between insurers and hospitals, taking payment contracts as given and taking expectations of hospital demand. OLS estimation of equations (2) and (3) would thus suffer from the standard simultaneity bias in linear supply models. The simultaneity bias arises because both the left-hand and right-hand side variables in each equation are determined in equilibrium.

We use instrumental variables to address this endogeneity issue. In the case of the FFS pricing function for c-sections, our instruments for hospital demand are the lagged negotiated c-section FFS price, the FFS price for vaginal deliveries, and the FFS indicator for vaginal deliveries. Our instruments for the c-section capitation price are the lagged negotiated c-section capitation prices, the vaginal delivery price under capitation, and the FFS indicator for vaginal deliveries. We use analogous instruments for the vaginal delivery pricing functions. We estimate the delivery pricing functions separately using GMM.

7 Estimation results

Delivery choice. Estimation results for our delivery choice model are reported in table 5. First-stage regression results of prices on instruments and exogenous variables are presented in appendix table 1. Consistent with the previous literature (e.g, Currie and MacLeod, 2017), we find that the probability of a c-section for women aged 35 or older, women with chronic diseases, and women with high-risk pregnancies, is significantly higher than for women under 35, healthy women, and women with low-risk pregnancies, respectively. C-sections are less common during the weekends, when doctors are less available and staffing numbers are lower.

TABLE 5: Delivery Choice Model Estimates

		Estimates	
		coef	se
C-section	Price	2.98	(0.26)
	FFS	5.22	(0.43)
	FFS × High risk pregnancy	1.74	(0.82)
Vaginal delivery	Price	-3.91	(0.34)
Demographics and health	Age 25-29	4.68	(0.23)
	Age 30-34	8.64	(0.26)
	Age 35 or more	14.23	(0.30)
	High risk pregnancy	3.39	(0.76)
	Chronic disease	2.68	(0.43)
Day of week	Monday	8.37	(0.35)
	Tuesday	9.19	(0.36)
	Wednesday	9.36	(0.34)
	Thursday	9.34	(0.35)
	Friday	9.59	(0.39)
	Saturday	5.53	(0.42)
	Sunday	(ref)	(ref)
R^2		0.12	
N		253,528	

Note: Maximum likelihood estimation of delivery choice model. Specification includes insurer and municipality fixed effects. Bootstrap standard error in parenthesis based on 100 resamples. Coefficients and standard errors are multiplied by 100.

Our findings show that financial characteristics of the contracts between insurers and hospitals significantly affect delivery choice. First, we find that the likelihood of a c-section increases by 3 percentage points (p.p) when the price of a c-section increases by \$100. This effect represents a 6% increase over the baseline fraction of c-sections.

Women are also 4 p.p less likely to receive a c-section if the price of a vaginal delivery increases by \$100. Second, we find that the likelihood of a c-section is 5 p.p higher if c-sections are covered under FFS and that responsiveness of c-section choice to FFS contracts is higher for high-risk pregnancies than for low-risk pregnancies.

Because our model includes insurer and municipality fixed effects, the effect of prices on delivery choice is identified from comparisons of c-section rates across hospitals conditional on women's observable characteristics. The fact that c-sections rates vary significantly across hospitals based on procedure prices is suggestive of hospitals responding to financial incentives in their treatment decisions. This finding is not unprecedented, qualitatively similar results are reported in Foo, Lee, and Fong (2017); Brekke, Holmås, Monstad, and Straume (2017); Shafrin (2010); Gruber, Kim, and Mayzlin (1999).

Hospital demand. Results of our hospital demand model are presented in table 6. Appendix table 2 presents first-stage results for our control function approach. We find that women are approximately 38 percent less likely to choose a hospital if its expected out-of-pocket delivery price increases by \$10. The average elasticity of hospital demand with respect to expected OOP FFS price equals -0.78 and with respect to expected OOP capitation price equals -0.64.[10] Hospital demand is approximately 62 percent lower if the expected payment contract under which the procedure will be reimbursed is FFS. The negative effect of FFS in hospital demand is lower for large insurers, which suggests this type of insurer has fewer incentives to steer patients away from expensive hospitals.

We find that women generally dislike having c-sections, but that the preference for c-sections is higher among women with high-risk pregnancies and with chronic diseases

[10]Elasticities of hospital demand with respect of expected OOP FFS prices and capitation prices are given by $\frac{p^1_{jh}}{s_{jh}} \sum_i \frac{\partial s_{ijh}}{\partial \hat{p}_{jh}}$ and $\frac{p^0_{jh}}{s_{jh}} \sum_i \frac{\partial s_{ijh}}{\partial \hat{p}_{jh}}$, respectively.

than their counterparts. Results also provide evidence of substantial hospital inertia, as women are nearly 6 times more likely to visit a hospital they had been to in the previous year.

Interactions of expected out-of-pocket prices with patient characteristics show that women aged 30 or more are less responsive to price than women under 30. Women with a chronic disease and living in urban municipalities are also less price sensitive than healthy women and than those living in rural municipalities, respectively. Findings show that low-income women or those earning less than two times the monthly minimum wage are more responsive to expected out-of-pocket prices than high-income women. These results are consistent with the evidence of adverse selection presented in section 4.

Pricing functions. We present results of our reduced-form pricing functions for c-sections in table 7 and for vaginal deliveries in table 8. The tables report estimates for ω, τ, and κ, as well as the predicted average marginal cost under FFS, the predicted base transfer under capitation, the predicted median markup, and the first-stage F statistics. First-stage regressions for the endogenous variables are reported in Appendix Tables 5 and 6.

We find that hospital markups under FFS are greater for c-sections than for vaginal deliveries. This is in line with the observed over-provision of c-sections and with hospitals providing the most profitable service covered under FFS. Under a capitation contract, we find that markups are greater for vaginal deliveries than for c-sections. Our result is consistent with low-complexity services being more likely to be provided under capitation. The predicted markup is not directly comparable across contracts since they have different units: capitation markups are accrued per enrollee, while

Table 6: Hospital Demand Model Estimates

		Estimates coef	se
Expected OOP ($100)		-3.86	(0.33)
Expected FFS contract		-0.99	(0.03)
Expected C-section		-4.76	(0.36)
Previous visit		1.75	(0.04)
Missing C-section FFS		-1.06	(0.02)
Missing Vaginal delivery FFS		-1.15	(0.02)
Interactions			
Expected OOP ($100)	Age 30 or more	1.00	(0.13)
	Chronic disease	1.28	(0.24)
	High-risk pregnancy	-0.54	(0.20)
	Rural	-5.92	(0.96)
	Low income	-0.26	(0.13)
Expected FFS contract	Large insurer	1.28	(0.06)
Expected C-section	Age 30 or more	0.34	(0.38)
	Chronic disease	1.93	(0.67)
	High-risk pregnancy	3.22	(0.51)
Previous visit	Age 30 or more	-0.09	(0.05)
	Chronic disease	-0.10	(0.06)
	High-risk pregnancy	-0.25	(0.05)
	Rural	-0.98	(0.06)
Pseudo-R^2		0.39	
N		774,809	

Note: Maximum likelihood estimation of hospital demand model. Specification includes interactions between number of beds, an indicator for bad outcomes post-delivery, and maternal mortality rate for each hospital with patient characteristics including dummies for age group, having a chronic disease, having a high-risk pregnancy, and zone of residence. Specification also includes hospital fixed effects. Bootstrap standard errors in parenthesis based on 100 resamples.

FFS markups are accrued per claim.[11]

In accordance with the predictions of our bargaining model in appendix B, we find that FFS prices for c-sections are a decreasing function of average capitation transfers. We also estimate a zero effect of average capitation transfers on FFS prices for vaginal deliveries. Estimates of the capitation pricing functions show that unit capitation prices are increasing in average FFS prices for both c-sections and vaginal deliveries. This suggests that consumers disproportionately substitute away from hospitals covered under FFS toward hospitals covered under capitation following a FFS price increase. Our estimates imply that the average marginal cost under FFS equals \$264 for a c-section and \$242 for a vaginal delivery. Moreover, the average base capitated transfer is \$311 for a c-section and \$187 for a vaginal delivery.

TABLE 7: C-Section Pricing Function Estimates

	FFS		Cap	
	coef	se	coef	se
Markup 1	4.30	(0.48)	0.06	(0.01)
Markup 2	-0.01	(0.01)	6.72	(1.28)
Mean FFS price	—	—	0.01	(0.00)
Mean marginal cost/Base transfer	2.64	(1.25)	3.11	(1.88)
F-stat Markup 1	18.45		36.07	
Predicted median markup	19.39		5.00	
N	577		154	
R^2	0.50		0.90	

Note: Instrumental variable regressions of the pricing function for c-sections under FFS and capitation. Markup 1 under FFS corresponds to $\left(\frac{\partial s_{ijh}}{\partial p^1_{jh}} + \left(\frac{\partial W_j}{\partial p^1_{jh}} - \frac{\partial TC_j}{\partial p^1_{jh}}\right)\right)^{-1} s_{jh}$. Markup 2 under FFS corresponds to $\left(\frac{\partial s_{ijh}}{\partial p^1_{jh}} + \left(\frac{\partial W_j}{\partial p^1_{jh}} - \frac{\partial TC_j}{\partial p^1_{jh}}\right)\right)^{-1} \overline{p}^0_j$. Markup 1 under capitation corresponds to $\left(\frac{\partial W_j}{\partial p^0_{jh}} - \frac{\partial TC_j}{\partial p^0_{jh}}\right)^{-1} s_{jh}\overline{p}^1_j$. Markup 2 under capitation corresponds to $\left(\frac{\partial W_j}{\partial p^0_{jh}} - \frac{\partial TC_j}{\partial p^0_{jh}}\right)^{-1} \left(\frac{\partial s_{jh}}{\partial p^0_{jh}} p^1_{jh}\right)$. Specifications include insurer and municipality fixed effects. Table reports the first-stage F statistic for Markup 1, the average marginal cost under FFS or average base transfer under capitation, and the predicted median markup. Robust standard errors in parenthesis.

[11] Hospital markups under FFS are calculated as $\left(\frac{\partial s_{jh}}{\partial p^1_{jh}} + \left(\frac{\partial W_j}{\partial p^1_{jh}} - \frac{\partial TC_j}{\partial p^1_{jh}}\right)\right)^{-1} (\hat{\omega}^1 s_{jh} + \hat{\tau}^1 \overline{p}^0_j)$ and under capitation are calculated as $-\hat{\tau}^0 \left(\frac{\partial W_j}{\partial p^0_{jh}} - \frac{\partial TC_j}{\partial p^0_{jh}}\right)^{-1} \left(\frac{\partial s_{jh}}{\partial p^0_{jh}} p^1_{jh}\right)$. We report the median of this prediction across insurer-hospital pairs in the tables.

Table 8: Vaginal Delivery Pricing Function Estimates

	FFS		Cap	
	coef	se	coef	se
Markup 1	3.63	(0.41)	0.12	(0.03)
Markup 2	0.02	(0.01)	11.0	(3.08)
Mean FFS price	—	—	0.01	(0.00)
Mean marginal cost/Base transfer	2.42	(1.30)	1.87	(2.04)
F-stat Markup 1	18.55		8.66	
Predicted median markup	2.27		127	
N	584		130	
R^2	0.62		0.89	

Note: Instrumental variable regressions of the pricing function for vaginal deliveries under FFS and capitation. Markup 1 under FFS corresponds to $\left(\frac{\partial s_{ijh}}{\partial p^1_{jh}} + \left(\frac{\partial W_j}{\partial p^1_{jh}} - \frac{\partial TC_j}{\partial p^1_{jh}}\right)\right)^{-1} s_{jh}$. Markup 2 under FFS corresponds to $\left(\frac{\partial s_{ijh}}{\partial p^1_{jh}} + \left(\frac{\partial W_j}{\partial p^1_{jh}} - \frac{\partial TC_j}{\partial p^1_{jh}}\right)\right)^{-1} \overline{p}^0_j$. Markup 1 under capitation corresponds to $\left(\frac{\partial W_j}{\partial p^0_{jh}} - \frac{\partial TC_j}{\partial p^0_{jh}}\right)^{-1} s_{jh}\overline{p}^1_j$. Markup 2 under capitation corresponds to $\left(\frac{\partial W_j}{\partial p^0_{jh}} - \frac{\partial TC_j}{\partial p^0_{jh}}\right)^{-1} \left(\frac{\partial s_{jh}}{\partial p^0_{jh}} p^1_{jh}\right)$. Specifications include insurer and municipality fixed effects. Table reports the first-stage F statistic for Markup 1, the average marginal cost under FFS or average base transfer under capitation, and the predicted median markup. Robust standard errors in parenthesis.

8 Equilibrium Effects of Contract Regulation

The rapid increase in c-section rates and the large variation in delivery prices across hospitals are problematic for health outcomes after childbirth and health care costs. While policies that cap the number of c-sections directly may halt this increase, they may not be efficient at eliminating price variation across hospitals nor at reducing c-sections among low-risk women necessarily.[12] In this section, we use our model estimates to assess the impact of contract regulation on the expected number of c-sections, negotiated delivery prices, and health outcomes.

We conduct two counterfactual exercises to this end. In the first counterfactual we set the payment contract for both c-sections and vaginal deliveries to be FFS across all

[12] In trying to reduce the c-section rate, the state of California in the US for example established a cap on the number of c-sections certain hospitals could perform (California Health Care Foundation, 2022).

insurer-hospital pairs. In the second counterfactual, we set the payment contract for both services to capitation across all insurer-hospital pairs. For simplicity, we conduct our counterfactual simulations with data from Bogotá only, which is the capital city of Colombia and where 43 percent of all deliveries are performed. Even though payment contracts are endogenous and arise in equilibrium as a result of competition between insurer-hospital pairs, we think of these counterfactuals as government mandates over which types of services can be covered under which payment contracts.

Note that our counterfactuals involve changing the pricing function for each insurer-hospital pair in the data. However, conditional on the service we observe each hospital being covered under either FFS or capitation but typically not both. To conduct our counterfactual exercises we thus need to predict the structural error term for each hospital under each payment contract for both c-sections and vaginal deliveries. We adopt the following procedure to predict the structural error term in our first counterfactual: first, if hospital h and insurer j have a FFS contract for vaginal deliveries and a capitation contract for c-sections, we impose the FFS vaginal delivery error term on the FFS c-section pricing function.

Second, if hospital h and insurer j cover both c-sections and vaginal deliveries under capitation, then for the c-section (vaginal delivery) FFS pricing function we use hospital h's average c-section (vaginal delivery) FFS error term across all other insurers $-j$ with which it has c-sections (vaginal deliveries) covered under FFS.

Third, if hospital h has c-sections and vaginal deliveries covered under capitation with every insurer, then for the c-section (vaginal delivery) FFS pricing function with insurer j we use insurer j's average c-section FFS error term with all hospitals in its network that have a FFS contract for c-sections (vaginal deliveries). We predict the structural error terms for our second counterfactual in a similar fashion.

Computation of our counterfactuals proceeds as a fixed point. In the case of the full FFS counterfactual, we start with the observed price vector, then we predict delivery choice and hospital demand setting $f_{jh}^{cf} = g_{jh}^{cf} = 1$, where the upperscript cf denotes the counterfactual. This gives us new predictions of the derivatives of hospital and insurer profits, which in turn provides new price predictions. In these counterfactuals we fix $\overline{p}_j^0$ and $\overline{p}_j^1$ to their respective values in the observed equilibrium. Moreover, note that in the full capitation counterfactual the first term of equation (3) shrinks to zero as $\frac{\partial s_{jh}}{\partial p_{jh}^0} p_{jh}^{1,cf} = 0$.

8.1 Prices and Delivery Choice

TABLE 9: Counterfactual distribution of prices

	Mean	SD	Q1	Q3
Panel A. C-section				
$f_{jh} = 1$: Full FFS	401.8	125.4	306.8	515.3
$f_{jh} = 1$: Observed FFS	379.1	135.1	249.5	515.3
$f_{jh} = 0$: Full Cap	415.5	123.4	337.2	451.6
$f_{jh} = 0$: Observed Cap	376.5	101.9	326.4	434.8
Vaginal delivery				
$g_{jh} = 1$: Full FFS	340.4	123.6	222.8	443.4
$g_{jh} = 1$: Observed FFS	331.8	127.7	205.7	443.4
$g_{jh} = 0$: Full Cap	393.0	93.3	345.3	429.9
$g_{jh} = 0$: Observed Cap	376.9	95.9	344.3	423.7

Note: Table shows mean, standard deviation, and 1st and 3rd quantiles of the distribution of c-section prices and vaginal delivery prices for the observed scenario and two counterfactuals: both procedures covered under FFS ("Full FFS"), and both procedures covered under capitation ("Full Cap").

Table 9 shows the distribution of counterfactual and observed delivery prices for c-sections in panel A and for vaginal deliveries in panel B. Price statistics in the table are weighted by demand and are calculated conditional on payment contracts in the observed scenario to allow for an apples-to-apples comparison of prices between the counterfactual and the observed scenario.

We find that a full FFS contract regime increases average c-section prices by 6 percent and average vaginal delivery prices by 3 percent. For both procedures, the price distribution becomes less dispersed compared to the observed scenario. Both the FFS price increase and the lower price dispersion are the result of hospitals driving up costs by shifting demand towards the most expensive treatment. FFS prices increase because of hospital moral hazard despite the fact that there is more hospital competition or that more hospitals bargain FFS contracts with insurers relative to the observed equilibrium.

Moving towards a fully capitated regime results in a 10 percent increase of average c-section prices and a 4 percent increase in average vaginal delivery prices. Both price distributions become less dispersed compared to the observed scenario. The capitation price increase is explained by the fact that per-enrollee transfers need to at least cover the delivery cost of the most expensive woman in order for the Nash bargaining surplus to be non-negative. This "marginal" woman is different in the counterfactual compared to the observed scenario. The reduced price dispersion may also be suggestive of the patient mix becoming more similar across hospitals.

TABLE 10: Counterfactual distribution of expected number of c-sections per hospital

	Number of c-sections						
	Mean	SD	Q1	Q3	C-section Likelihood	Total High Risk	Total Low Risk
Full FFS	284.8	337.2	13.3	493.3	0.432	2,218.0	10,313.4
Full Cap	257.2	306.9	9.8	505.9	0.380	2,067.3	9,247.6
Observed	276.2	323.3	8.1	539.6	0.418	1,984.7	10,165.9

Note: Table shows mean, standard deviation, and 1st and 3rd quantiles of the distribution of expected number of c-sections per hospital for the observed scenario and two counterfactuals: both c-sections and vaginal deliveries covered under FFS ("Full FFS"), and both c-sections and vaginal deliveries covered under capitation ("Full Cap"). Table also reports average c-section likelihood and total number of c-sections among high-risk and low-risk pregnancies.

Table 10 shows the distribution of observed and counterfactual expected number of c-sections per hospital. The table also reports the average c-section likelihood and the expected total number of c-sections among high-risk and low-risk pregnancies. The average c-section likelihood is given by $(1/N_{ij}) \sum_{ij} \phi_{ijh}$ and the expected number of c-sections is given by $\sum_{ij} \phi_{ijh} s_{ijh}$.

We find that relative to the observed equilibrium, imposing a full FFS regime results in more c-sections, and greater variation in c-section rates across hospitals. Greater use of c-sections is consistent with hospital moral hazard in the presence of retrospective payment structures. We find that the likelihood of a c-section increases 1.4 p.p under full FFS, a change that is mostly explained by the direct effect of payment contracts on delivery choice.

Imposing a full capitation regime results in a 7 percent reduction in the average number of c-sections per hospital. With prospective payment structures, hospitals shift towards vaginal deliveries, which are associated with lower post-delivery costs. The full capitation regime thus reduces the impact of hospital moral hazard on delivery choice. We find that the likelihood of a c-section goes from 41.8 percent in the observed scenario to 38.0 percent in this counterfactual.

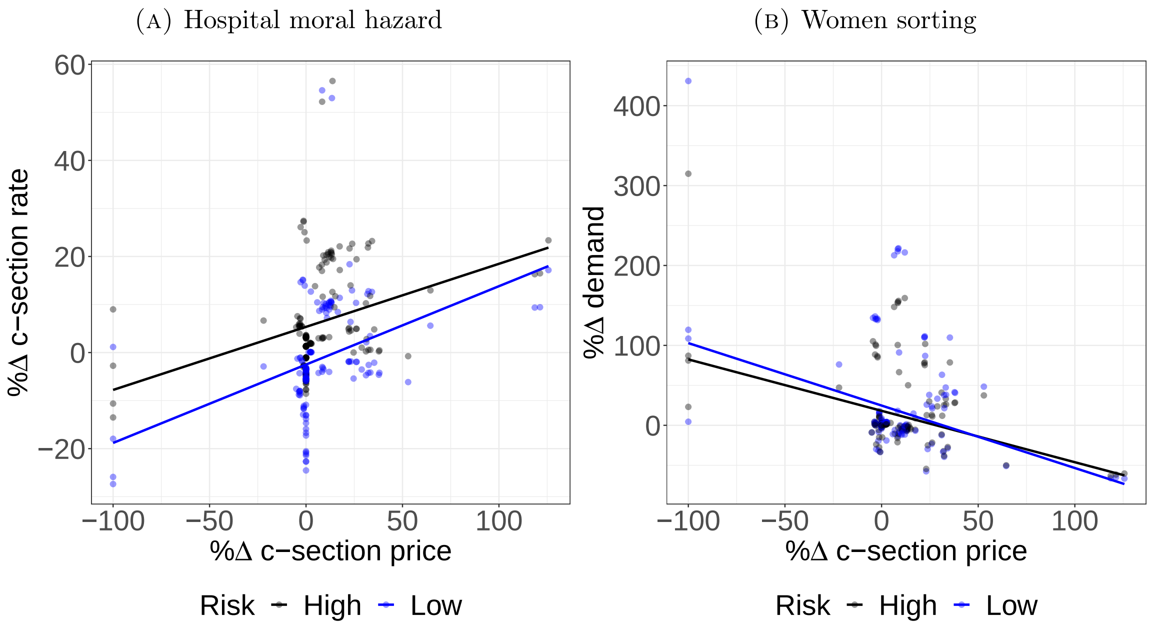
In the last two columns of table 10, we see that the increase in the number of c-sections under full FFS happens across both high-risk and low-risk pregnancies. The number of c-sections increases by a greater magnitude among the former (11.8 percent) than among the latter (1.4 percent). This finding suggests that even though a fully retrospective payment regime is detrimental for the purpose of reducing the c-section rate, it does not exacerbate the use of medically unnecessary c-sections. In the case of full capitation, we find an increase in the total number of c-sections among high-risk pregnancies but a substantial reduction among low-risk pregnancies. A prospective payment regime is therefore effective at reducing c-section rates, with effects stemming from a reduction in medically unnecessary procedures.

While we cannot extrapolate our findings to health systems with different market structure, our results do shed light on the type of regulation that can more effectively tackle the c-section epidemic. The California Health Care Foundation, for example, found that introducing reforms to payment incentives, data transparency, and patient engagement, could reduce the c-section rate in the state of California from 26.0 to 22.8 percent.[13] We find that regulation of payment contracts between insurers and hospitals, and in particular implementation of bundled payments such as capitation, can generate reductions as large as 9 percent in the number of c-sections among low-risk women.

The significant changes in the number of c-sections conditional pregnancy risk raise the question of whether these changes are driven by variation in hospital moral hazard or by women sorting differently across hospitals relative to the observed equilibrium. In figures 3 and 4 we explore these mechanisms for the full FFS and the full capitation counterfactuals, respectively. The figures show, conditional on high- and low-risk pregnancies, the correlation between changes in c-section likelihood (ϕ_{ijh}) and changes in c-section prices in panel A; and the correlation between changes in demand (s_{ijh}) and changes in c-section prices in panel B. Each dot corresponds to an insurer-hospital pair. Blue lines represent a linear fit for low-risk pregnancies and black lines represent a linear fit for high-risk pregnancies.

[13] See https://www.chcf.org/project/reducing-unnecessary-c-sections/#related-links-and-downloads

FIGURE 3: C-section rate, demand, and c-section price by pregnancy risk under full FFS



Under a full FFS regime, we find that hospital moral hazard –as measured by changes in the c-section likelihood– rather than women sorting, is the main driver of changes in the number of c-sections among high-risk pregnancies. For low-risk women, who are more responsive to price, sorting across hospitals offsets changes in the c-section rate. Under a full capitation regime in figure 4, we find that the reduction in the number of c-sections is mainly explained by changes in women sorting rather than by changes in hospital moral hazard. The figure also shows that the effect of women sorting is of similar magnitude for high-risk and low-risk women.

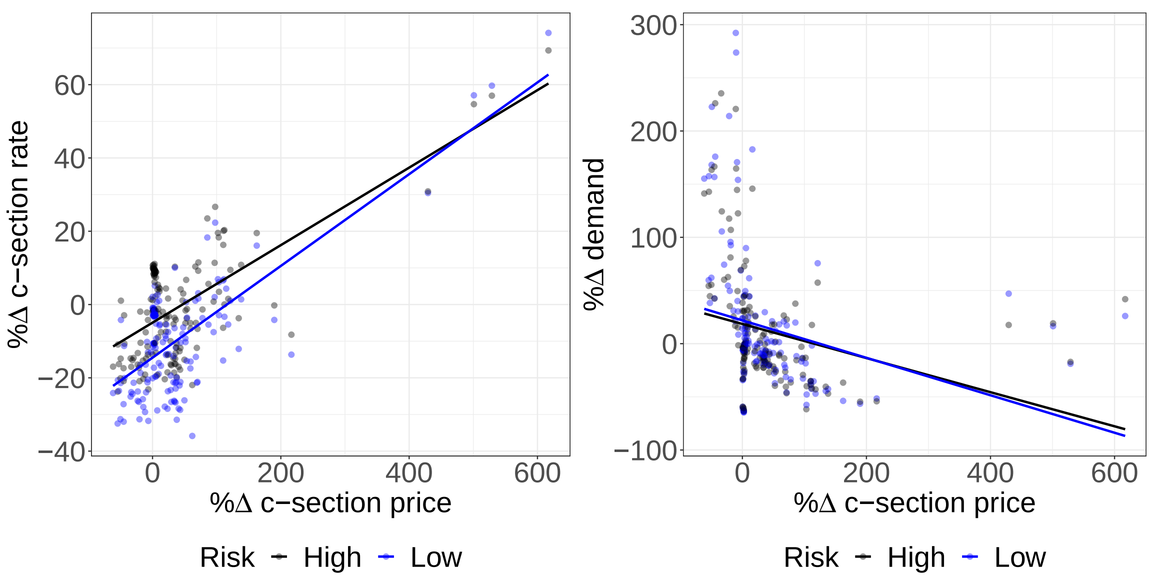
Table 11: Counterfactual distribution of delivery health care expenditure

	Delivery costs			
	Mean	SD	Q1	Q3
Full FFS	2,890.4	3,875.4	92.6	6,046.8
Full Cap	3,054.4	4,071.2	68.6	5,521.6
Observed	2,697.0	3,758.6	59.4	4,712.3

Note: Table shows mean, standard deviation, and 1st and 3rd quantiles of the distribution of expected delivery expenditure per hospital for the observed scenario and two counterfactuals: both c-sections and vaginal deliveries covered under FFS ("Full FFS"), and both c-sections and vaginal deliveries covered under capitation ("Full Cap").

Figure 4: C-section rate, demand, and c-section price by pregnancy risk under full Cap

(A) Hospital moral hazard (B) Women sorting



In table 11 we turn to the effect of payment contracts on total delivery cost per hospital given by $\sum_{ij} \phi_{ijh} p_{jh} s_{ijh} + (1 - \phi_{ijh}) q_{jh} s_{ijh}$. We report the mean, standard deviation, and 1st and 3rd quantiles of the distribution of this variable in the counterfactuals and in the observed scenario. Delivery costs per hospital increase under both counterfactual contract regimes. In the case of full capitation, the increase in costs is attributable to the increase in the number of high-risk pregnancies that receive a c-section. The higher c-section rate among relatively sicker women raises the minimum per-enrollee transfer that the hospital needs in order to make non-negative profits. In the case of full FFS, the increase in total costs is attributable to hospitals disproportionately choosing c-sections, which are relatively more expensive than vaginal deliveries.

8.2 A Note on Maternal Health Outcomes

To analyze the impact of payment contracts on maternal health outcomes post-delivery, we want to predict health outcomes at every possible hospital in the woman's choice set with a regression in the spirit of Abaluck, Caceres Bravo, Hull, and Starc (2021):

$$y_{ijh} = \sum_h \mu_h D_{ijh} + \theta_1 f_{ijh} + \theta_2 p_{jh} + \theta_3 q_{jh} + \gamma 1\{\text{c-section}_{ijh}\} + x_i'\beta + \eta_j + \upsilon_{ijh} \quad (4)$$

Here y_{ijh} is an outcome of woman i enrolled to insurer j who has her baby delivered at hospital h, D_{ijh} is an indicator variable for woman i choosing hospital h, f_{ijh} is an indicator variable for the procedure being covered under FFS, p_{jh} and q_{jh} are hospital h's price for c-sections and vaginal deliveries with insurer j, respectively, x_i are the woman's characteristics, and η_j is an insurer fixed effect. We include the FFS indicator directly into the health outcome function to capture the effect of hospital moral hazard on women's health.

Naturally, the prediction of health outcomes is biased due to selection: women may non-randomly choose their delivery hospital based on characteristics that are unobserved to us. We cannot control for such unobserved heterogeneity using individual fixed effects nor lagged health outcomes, since our data has one observation per woman and this observation corresponds to the woman's first delivery. Instead, we estimate equation (4) on the sample of inertial women: those who do not switch insurer nor hospital. Inertial women in terms of hospital choice are those who visited the delivery hospital the year prior to childbirth for health care that may be unrelated to obstetric care. For inertial women, changes in prices and payment contracts are as-if-random. Appendix table 7 presents regression estimates and appendix figure 1 presents hospital fixed effects estimates.

We can then use the estimated parameters to simulate health outcomes under our observed and counterfactual scenarios as:

$$\hat{y}_{ijh} = \hat{\mu}_h \hat{s}_{ijh} + \hat{\theta}_1 \hat{f}_{ijh} + \hat{\theta}_2 \hat{p}_{jh} + \hat{\theta}_3 \hat{q}_{jh} + \hat{\gamma}\hat{\phi}_{ijh} + x_i'\hat{\beta} + \hat{\eta}_j$$

where $\hat{s}_{ijh}$ is the hospital choice probability, $\hat{f}_{ijh}$ is the expected payment contract, $\hat{p}_{jh}$ and $\hat{q}_{jh}$ are c-section and vaginal delivery prices, respectively, and $\hat{\phi}_{ijh}$ is the expected delivery procedure. Table 12 shows the distribution of observed and counterfactual health outcomes. An observation for this table is a woman. We consider four types of health outcomes in the month after having the baby, all combined into one indicator variable: hospitalization, hemorrhage (ICD10 code R85), puerperal sepsis (ICD10 code O85), and infection of obstetric surgical wound (ICD10 code O86). Thus, y_{ijh} reflects the probability that the woman has a bad outcome the month after delivery.

We find that imposing a full FFS regime results in higher rates of bad outcomes post-delivery, while imposing a full capitation regime results in lower rates of bad outcomes relative to the observed scenario. Under full FFS, women are 2 p.p more likely to be hospitalized in the month after delivery or to have an infection of obstetric wounds. This effect is driven by the increase in c-section rates and by lower-quality hospitals choosing FFS with insurers. Under full capitation, the improvement in women's health stems primarily from women reallocating towards higher-quality hospitals and from the reduction in c-sections, which are a more invasive procedure.

Table 12: Counterfactual distribution of health outcomes

	Bad health outcome			
	Mean	SD	Q1	Q3
Full FFS	0.056	0.078	-0.025	0.091
Full Cap	-0.014	0.086	-0.087	0.023
Observed	0.034	0.090	-0.075	0.090

Note: Table shows mean, standard deviation, and 1st and 3rd quantiles of the distribution of bad health outcomes in the month after delivery for the observed scenario and two counterfactuals: both c-sections and vaginal deliveries covered under FFS ("Full FFS"), and both c-sections and vaginal deliveries covered under capitation ("Full Cap"). Bad health outcome is an indicator variable for any of the following procedures/diagnoses received within one month after delivery: hospitalization, hemorrhage (ICD10 code R85), puerperal sepsis (ICD10 code O85), or infection of obstetric surgical wound (ICD10 code O86).

9 Conclusions

Public payers seeking to reduce the use of intensive, expensive treatments might do so directly by capping its use, or indirectly by regulating reimbursements for those services. In this paper, we quantify the impact of regulating payment contracts between insurers and hospitals on the decision to perform c-sections and on negotiated prices for deliveries. We study this question in the context of the Colombian health-care system. In Colombia, as in many other countries, c-section rates have increased rapidly over the last two decades, contributing to rising health care costs and bad maternal health outcomes. Our results indicate that moving to a system where both c-sections and vaginal deliveries are reimbursed on a capitated basis rather than a fee-for-service basis, is effective at reducing the expected number of c-sections, but has little effect on the price variation across hospitals. However, the reduction in the c-section rate is of similar magnitude among low-risk and high-risk pregnancies.

Our findings speak more broadly to the type of regulation that can help align provider incentives with patient preferences when health care prices are negotiated. While our counterfactuals suggest that contract regulation is one such potential avenue, our framework does not allow us to study the implications of such policies on the insurers' decision of which hospitals to cover under which contracts. Future research may focus on endogeneizing the choice of payment contracts between insurers and hospitals.

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Appendix A Obtaining Negotiated Prices from Claims

Separately for every insurer j and type of delivery s (vaginal or c-section), we estimate the following linear regression:

$$\tilde{p}_{ijhs} = x_i'\beta_1 + \beta_2 f_{jhs} + \gamma_h + \epsilon_{ijhs}$$

where $\tilde{p}_{ijhs}$ is the reported price, x_i are patient characteristics including age, an indicator for whether the woman has a chronic disease, and the woman's length-of-stay; f_{jhs} is an indicator for whether the type of delivery s is covered under FFS between insurer j and hospital h; and γ_h is a hospital fixed effect.

Denote by $\hat{E}[\tilde{p}_{ijhs}|x_i, f_{jhs}, h]$ the predictions from these linear regressions. The negotiated price for each hospital-insurer-service under contract $k \in \{\text{FFS}, \text{Cap}\}$, p^k_{jhs}, is then:

$$p^k_{jhs} = \frac{1}{N_{j,h,s}} \sum_{j,h,s} \hat{E}[\tilde{p}_{ijhs}|x_i, f_{jhs} = k, h]$$

where $N_{j,h,s}$ is the number of women who had delivery claims of type s in insurer j and hospital h.

Appendix B Reduced-Form Pricing Model

Assume that insurers and hospitals bargain over the price of a service covered in a FFS contract and the unit price of a service under a capitation contract, holding hospital networks fixed. In a more flexible model that allows for insurer choice, we can write insurer profits as:

$$\pi^j = \sum_i r_i \sigma_{ij}(p^1_{jh}, p^0_{jh}) - \sum_{h \in F_j} \sum_i (1 - c_i) p^1_{jh} s_{ijh}(p^1_{jh}, p^0_{jh}) - \sum_{h \in K_j} p^0_{jh} \sigma_j(p^1_{jh}, p^0_{jh})$$

where r_i is the risk-adjusted transfer from the government to the insurer for each of its enrollees, σ_{ij} is the choice probability of consumer i for insurer j, and $\sigma_j = \sum_i \sigma_{ij}$ is total insurer demand. Moreover, $s_{jh} = \sum_i s_{ijh}$ denotes total hospital demand from insurer j's enrollees with s_{ijh} representing consumer i's choice probability, p^1_{jh} is the FFS price between insurer j and hospital h, F_j is insurer j's network of hospitals under FFS, p^0_{jh} is the unit price of the service under capitation, and K_j is insurer j's network of hospitals under a capitation contract. Conditional on the service, F_j and K_j are mutually exclusive, $F_j \cap K_j = \oslash$. In this profit function, insurers pay hospitals their FFS prices each time a person visits the hospital, but they pay capitation transfers for each enrollee regardless of whether they visit the hospital or not.

In this framework, hospital profits are given by:

$$\pi^h = \sum_{j \in F_h} (p^1_{jh} - m_{jh}) s_{jh}(p^1_{jh}, p^0_{jh}) + \sum_{j \in K_h} p^0_{jh} \sigma_j(p^1_{jh}, p^0_{jh})$$

where m_{jh} is the marginal cost to hospital h of providing the service to insurer j's enrollees, F_h is the set of insurers that cover hospital h under a FFS contract, and K_h is the set of insurers that cover hospital h under a capitation contract. Here also, conditional on the service $F_h \cap K_h = \oslash$.

B.1 Equilibrium FFS Prices

Define the log of the Nash surplus for a FFS contract as:

$$\log(S^1_{jh}) = \beta \log\left(\pi^j_{F_j,K_j} - \pi^j_{F_j\backslash h,K_j\cup h}\right) + (1-\beta)\log\left(\pi^h_{F_h,K_h} - \pi^h_{F_h\backslash j,K_h\cup j}\right)$$

Here β represents the bargaining power of the insurer. Note that the outside option for the insurer is not to drop the hospital altogether from its network as is typically done in the literature. Instead the outside option is to drop the hospital from the set that is covered under FFS, $F_j\backslash h$, and cover it under capitation, $K_j \cup h$. For the hospital, the outside option is analogous.

The first-order condition of the joint surplus maximization problem with respect to FFS prices is:

$$-\frac{\beta}{\left(\pi^j_{F_j,K_j} - \pi^j_{F_j\backslash h,K_j\cup h}\right)}\frac{\partial \pi^j_{F_j,K_j}}{\partial p^1_{jh}} = \frac{1-\beta}{\left(\pi^h_{F_h,K_h} - \pi^h_{F_h\backslash j,K_h\cup j}\right)}\frac{\partial \pi^h_{F_h,K_h}}{\partial p^1_{jh}}$$

Let $\mathbf{A}^1 = \frac{\partial \pi^j_{F_j,K_j}}{\partial p^1_{jh}}$, $\mathbf{B}^1 = \pi^j_{F_j,K_j} - \pi^j_{F_j\backslash h,K_j\cup h}$, $\Lambda^1 = \frac{\beta \mathbf{A}^1}{(1-\beta)\mathbf{B}^1}$, $\mathbf{d}^1 = \pi^h_{F_h\backslash j,K_h\cup j}$, $\Omega^1 = \frac{\partial s_{jh}}{\partial p^1_{jh}}$, and $\Gamma^1 = \frac{\partial \sigma_j}{\partial p^1_{jh}}$. After writing the first-order condition in matrix form and re-arranging terms, we get the following expression for equilibrium prices in a FFS contract:

$$\mathbf{p}^1 = \mathbf{m} - (\Omega^1 + \Lambda^1 \mathbf{s})^{-1}(\mathbf{s} + (\Gamma^1 + \Lambda^1\sigma)\mathbf{p}^0 - \Lambda^1\mathbf{d}^1) \qquad (5)$$

In this case, Λ^1, Ω^1 and Γ^1 are negative semidefinite. Therefore the expression shows that FFS prices are higher the higher is the hospital's disagreement payoff and the lower are the capitation transfers.

B.2 Equilibrium Capitation Prices

Now define the log of the Nash surplus for a capitation contract as:

$$\log(S^0_{jh}) = \beta \log\left(\pi^j_{F_j,K_j} - \pi^j_{F_j\cup h,K_j\backslash h}\right) + (1-\beta)\log\left(\pi^h_{F_h,K_h} - \pi^h_{F_h\cup j,K_h\backslash j}\right)$$

In this case the outside option for the insurer is to drop the hospital from the set that is covered under capitation, $K_j\backslash h$ and cover it under FFS, $F_j \cup h$. The disagreement payoff to the hospital is analogous.

The first-order condition of the joint surplus maximization problem with respect to unit prices in a capitation contract is:

$$-\frac{\beta}{\left(\pi^j_{F_j,K_j} - \pi^j_{F_j\cup h,K_j\backslash h}\right)}\frac{\partial \pi^j_{F_j,K_j}}{\partial p^0_{jh}} = \frac{1-\beta}{\left(\pi^h_{F_h,K_h} - \pi^h_{F_h\cup j,K_h\backslash j}\right)}\frac{\partial \pi^h_{F_h,K_h}}{\partial p^0_{jh}}$$

Let $\mathbf{A}^0 = \frac{\partial \pi^j_{F_j,K_j}}{\partial p^0_{jh}}$, $\mathbf{B}^0 = \pi^j_{F_j,K_j} - \pi^j_{F_j\cup h,K_j\backslash h}$, $\Lambda^0 = \frac{\beta \mathbf{A}^0}{(1-\beta)\mathbf{B}^0}$, $\mathbf{d}^0 = \pi^h_{F_h\cup j,K_h\backslash j}$, $\Omega^0 = \frac{\partial s_{jh}}{\partial p^0_{jh}}$, and $\Gamma^0 = \frac{\partial \sigma_j}{\partial p^0_{jh}}$. Re-writing the first-order condition in matrix form and re-arranging terms yields the following expression for the unit price in a capitation contract:

$$\mathbf{p}^0 = (\Lambda^0\sigma + \Gamma^0)^{-1}(\Lambda^0\mathbf{d}^0 - \sigma) - (\Lambda^0\sigma + \Gamma^0)^{-1}(\Omega^0 + \Lambda^0\mathbf{s})(\mathbf{p}^1 - \mathbf{m})$$

In the expression above, Ω^0 is positive semidefinite, while Λ^0 and Γ^0 are negative semidefinite, hence our model shows that the unit price under capitation is increasing in the hospital's disagreement payoff. However, the effect of FFS prices on unit capitation prices is ambiguous.[14] On the one side, unit capitation prices may increase with FFS prices if consumers are inertial with respect to their insurer and

[14]Note that Ω^0 captures the change in demand for hospitals covered under FFS with respect to a change in the capitation transfer at capitated hospitals.

disproportionately substitute away from FFS toward capitated hospitals following a FFS price increase. On the other side, unit capitation prices may decrease with FFS prices if consumers disproportionately switch out of their insurer following a FFS price increase.

B.3 Empirical Analogs

Let $TC_j = \sum_{h \in F_j} \sum_i (1 - c_i) p^1_{jh} s_{ijh}(p^1_{jh}, p^0_{jh}) + \sum_{h \in K_j} p^0_{jh} \sigma_j(p^1_{jh}, p^0_{jh})$ be the insurer's total cost for deliveries. p^1_{jh} and p^0_{jh} map to our data as the reported prices for deliveries covered under FFS and the reported unit prices for capitated deliveries, respectively. Because every woman in our sample makes one delivery claim, the total number of women enrolled with each insurer equals the total number of delivery services provided, or $\sigma_j(p^1_{jh}, p^0_{jh}) = \sum_{h \in K_j} \sum_i \sum_{h \in F_j \cup K_j} s_{ijh}(p^1_{jh}, p^0_{jh}) = \sum_{h \in K_j} \sum_i 1$. Therefore, reported prices for both capitation and FFS are measured at the service level.

Taking enrollment decisions as given, the empirical analog of the insurers' total cost is $TC_j = \sum_{h \in F_j} \sum_i (1 - c_i) p^1_{jh} s_{ijh}(p^1_{jh}, p^0_{jh}) + \sum_{h \in K_j} p^0_{jh} \hat{\sigma}_j$, where $\hat{\sigma}_j$ is the *fixed* market share of insurer j in the number of pregnant women. Let W_j be our approximation to insurer revenues as in Gowrisankaran et al. (2015), or the dollarized value of insurer j's network of hospitals. We derive a reduced-form expression for equilibrium FFS prices in market t from equation (5) as follows:

$$p^1_{jh} = \underbrace{\mu^1_j + \mu^1_{t(h)}}_{\mathbf{m}} - \underbrace{\left(\frac{\partial s_{jh}}{\partial p^1_{jh}} + \sum_{k \in F_j} \left(\frac{\partial W_j}{\partial p^1_{jh}} - \frac{\partial TC_j}{\partial p^1_{jh}} \right) s_{jk} \right)^{-1} \left(\omega^1 s_{jh} + \tau^1 \overline{p}^0_j \right)}_{(\Omega^1 + \Lambda^1 \mathbf{s})^{-1} (\mathbf{s} + (\Gamma^1 + \Lambda^1 \sigma) \mathbf{p}^0 - \Lambda \mathbf{d}^1)} + \epsilon^1_{jh}$$

where τ^1, ω^1, μ^1_j, and $\mu^1_{t(h)}$ are parameters to be estimated, $\overline{p}^0_j$ is insurer j's average capitation transfer with hospitals in its network, and ϵ^1 is the FFS structural error.

Inclusion of unit capitation prices in the FFS pricing function, $\overline{p}_j^0$, accounts for the hospital's disagreement payoff.

Our reduced-form expression for unit prices in a capitation contract is given by:

$$p_{jh}^0 = \underbrace{-\tau^0 \Big(\frac{\partial W_j}{\partial p_{jh}^0} - \frac{\partial TC_j}{\partial p_{jh}^0}\Big)^{-1} \Big(\frac{\partial s_{jh}}{\partial p_{jh}^0} p_{jh}^1\Big) - \omega^0 \Big(\frac{\partial W_j}{\partial p_{jh}^0} - \frac{\partial TC_j}{\partial p_{jh}^0}\Big)^{-1} s_{jh}\overline{p}_j^1}_{(\Lambda^0\sigma+\Gamma^0)^{-1}(\Omega^0+\Lambda^0\mathbf{s})(\mathbf{p}^1-\mathbf{m})}$$
$$+ \underbrace{\kappa^0 \frac{\overline{p}_j^1}{\hat{\sigma}_j} + \mu_j^0 + \mu_{t(h)}^0}_{(\Lambda^0\sigma+\Gamma^0)^{-1}(\Lambda^0\mathbf{d}^0-\sigma)} + \epsilon_{jh}^0$$

where $\overline{p}_j^1$ is insurer j's average FFS price with hospitals in its network, and $\kappa^0, \omega^0, \tau^0, \mu_j^0$, and $\mu_{t(h)}^0$ are parameters to be estimated.

Appendix C First-stage for Delivery Choice

Appendix D First-Stage for Hospital Demand

This appendix presents results for the first-stage regression for hospital demand. We estimate the following linear regression:

$$c_i\hat{p}_{jh} = \tau_1 p'_{jh} + \tau_2 q'_{jh} + \tau_3 \hat{f}_{ijh} + \tau_3 \hat{\phi}_{ijh} + x'_i\beta + \eta_h + \nu_{ijh}$$

where p'_{jh} and q'_{jh} are the average price for c-sections and vaginal deliveries in other markets, respectively; $\hat{f}_{ijh}$ is the expected payment contract; $\hat{\phi}_{ijh}$ is the c-section probability; and x_i is a vector of patient characteristics.

Appendix Table 1: First-Stage Estimates for Delivery Choice

		C-section price		Vaginal price	
		coef	se	coef	se
C-section price other markets		432.2	(19.2)	320.5	(15.3)
Vaginal delivery price other markets		-229.6	(10.4)	-174.9	(8.60)
Lagged c-section price		94.6	(0.22)	14.3	(0.19)
Lagged vaginal delivery price		-17.9	(0.28)	62.9	(0.27)
Demographics and health	Age 25-29	-0.53	(0.16)	-0.33	(0.17)
	Age 30-34	-0.81	(0.17)	-0.85	(0.18)
	Age 35 or more	-0.83	(0.21)	-1.11	(0.22)
	High risk pregnancy	-0.39	(0.23)	0.33	(0.26)
	Chronic disease	0.76	(0.32)	-0.93	(0.35)
Day of week	Monday	0.29	(0.25)	0.33	(0.28)
	Tuesday	0.62	(0.26)	0.55	(0.28)
	Wednesday	0.87	(0.26)	0.45	(0.28)
	Thursday	0.58	(0.26)	0.85	(0.28)
	Friday	0.21	(0.26)	0.47	(0.28)
	Saturday	0.15	(0.27)	-0.08	(0.30)
	Sunday	(ref)	(ref)	(ref)	(ref)
Missing lagged c-section price		338.8	(1.14)	28.7	(1.09)
Missing lagged vaginal delivery price		-85.9	(1.09)	180.5	(1.15)
R^2		0.93		0.93	
N		253,528		253,528	

Note: First-stage results of delivery choice model. Linear regressions of c-section price and vaginal delivery price on the average price in other markets and lagged prices. Specifications include insurer and municipality fixed effects. Robust standard errors in parenthesis. Coefficients and standard errors are multiplied by 100.

Appendix E Robustness Checks on Demand

Table 3 in this appendix compares our main estimates of hospital demand against those without using a control function for the expected out-of-pocket price. Table 4 presents a robustness exercise to our sample selection criteria. Column (1) shows our main hospital demand specification estimated on the sample of women who do not switch their insurer and whose enrollment may not be continuous. Column (2) shows results on the sample of women who do not switch their insurer and have continuous enrollment spells. Column (3) shows results using the full sample of women without

Appendix Table 2: First-Stage Estimates for Hospital Demand

	OOP Price	
	coef	se
Vaginal delivery price other markets	0.76	(0.31)
C-section price other markets	-45.01	(0.60)
Expected FFS contract	-9.71	(0.30)
Expected c-section	-49.28	(0.16)
Previous visit	-1.79	(0.09)
Missing C-section FFS	5.59	(0.05)
Missing Vaginal delivery FFS	-2.80	(0.06)
Chronic disease	1.60	(0.05)
High-risk pregnancy	4.67	(0.04)
Age 30 or more	-4.16	(0.03)
Rural	-7.63	(0.12)
Low income	-23.31	(0.04)
Number of beds	-1.03	(0.07)
Bad outcomes	9.27	(0.38)
Maternal mortality	-6.04	(0.22)
Adjusted R^2	0.61	
N	774,809	

Note: First-stage OLS regression of out-of-pocket prices on the lagged out-of-pocket price and patient characteristics. Coefficients and standard errors are multiplied by 100 for exposition. Specification includes hospital fixed effects.

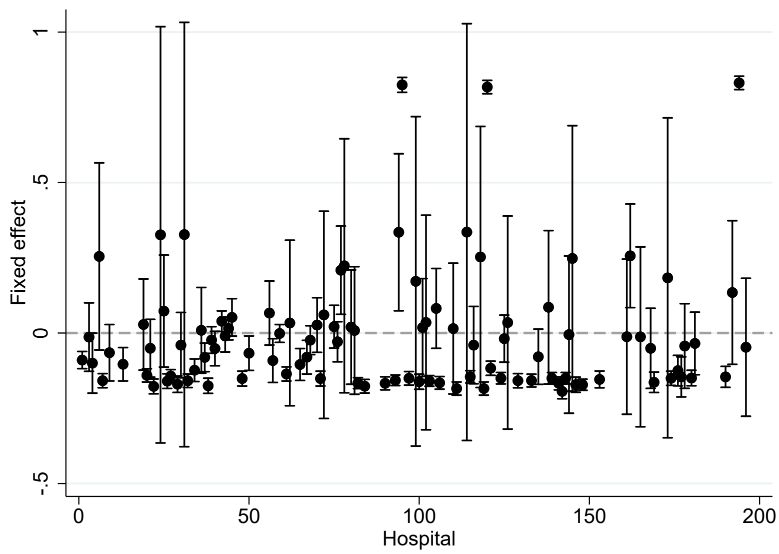
constraints on switching nor enrollment length.

Appendix F First-Stage for Pricing Functions

This appendix presents results for the first-stage regression of the pricing function for c-sections and vaginal deliveries. We use as instruments for demand and its derivatives, the lagged delivery prices. For c-sections, we also use the price and contract type of vaginal deliveries as instruments, and viceversa.

Appendix G Health Outcomes

Appendix Table 1: Hospital Fixed Effects in Health Outcomes Function



Appendix Table 3: Hospital Demand Model Estimates Without Control Function

		(1) Main		(2) No control function	
		coef	se	coef	se
Expected OOP ($100)		-3.86	(0.33)	-1.04	(0.11)
Expected FFS contract		-0.99	(0.03)	-0.98	(0.03)
Expected -section		-4.76	(0.36)	-3.82	(0.35)
Previous visit		1.75	(0.04)	1.81	(0.04)
Missing C-section FFS		-1.06	(0.02)	-1.17	(0.02)
Missing Vaginal delivery FFS		-1.15	(0.02)	-1.12	(0.02)
Interactions					
Expected OOP ($100)	Age 30 or more	1.00	(0.13)	0.97	(0.11)
	Chronic disease	1.28	(0.24)	1.20	(0.21)
	High-risk pregnancy	-0.54	(0.20)	-0.59	(0.18)
	Rural	-5.92	(0.96)	-0.06	(0.28)
	Low income	-0.26	(0.13)	-0.32	(0.12)
Expected FFS contract	Large insurer	1.28	(0.06)	1.30	(0.06)
Expected C-section	Age 30 or more	0.34	(0.38)	0.20	(0.37)
	Chronic disease	1.93	(0.67)	1.80	(0.66)
	High-risk pregnancy	3.22	(0.51)	3.30	(0.51)
Previous visit	Age 30 or more	-0.09	(0.05)	-0.09	(0.05)
	Chronic disease	-0.10	(0.06)	-0.10	(0.06)
	High-risk pregnancy	-0.25	(0.05)	-0.26	(0.05)
	Rural	-0.98	(0.06)	-0.88	(0.06)
Pseudo-R^2		0.39		0.39	
N		774,809		774,809	

Note: Hospital demand in the main sample with control function in column (1) and without control function in column (2). Specifications include interactions between number of beds, an indicator for bad outcomes post-delivery, and maternal mortality rate for each hospital with patient characteristics including dummies for age group, having a chronic disease, having a high-risk pregnancy, and zone of residence. Specifications also include hospital fixed effects. Bootstrap standard errors in parenthesis based on 100 resamples.

Appendix Table 4: Hospital Demand Model Estimates in Alternative Samples

		(1) No switch Not contin.	(2) No switch Continuous	(3) Switch Not contin.
Expected OOP ($100)		-3.86	-4.16	-4.15
		(0.33)	(0.38)	(0.29)
Expected FFS contract		-0.99	-1.01	-1.02
		(0.03)	(0.03)	(0.02)
Expected c-section		-4.76	-4.76	-4.89
		(0.36)	(0.41)	(0.32)
Previous visit		1.75	1.75	1.73
		(0.04)	(0.04)	(0.04)
Missing C-section FFS		-1.06	-1.08	-1.04
		(0.02)	(0.02)	(0.02)
Missing Vaginal delivery FFS		-1.15	-1.13	-1.18
		(0.02)	(0.02)	(0.02)
Interactions				
Expected OOP ($100)	Age 30 or more	1.00	1.16	1.00
		(0.13)	(0.15)	(0.11)
	Chronic disease	1.28	1.39	1.26
		(0.24)	(0.25)	(0.25)
	High-risk pregnancy	-0.54	-0.69	-0.58
		(0.20)	(0.21)	(0.20)
	Rural	-5.92	-6.08	-5.75
		(0.96)	(1.12)	(0.79)
	Low income	-0.26	-0.29	-0.05
		(0.13)	(0.15)	(0.12)
Expected FFS contract	Large insurer	1.28	1.33	1.29
		(0.06)	(0.07)	(0.05)
Expected c-section	Age 30 or more	0.34	0.43	0.75
		(0.38)	(0.43)	(0.32)
	Chronic disease	1.93	1.98	1.91
		(0.67)	(0.67)	(0.66)
	High-risk pregnancy	3.22	3.32	2.87
		(0.51)	(0.53)	(0.50)
Previous visit	Age 30 or more	-0.09	-0.07	-0.08
		(0.05)	(0.05)	(0.05)
	Chronic disease	-0.10	-0.11	-0.11
		(0.06)	(0.06)	(0.06)
	High-risk pregnancy	-0.25	-0.25	-0.25
		(0.05)	(0.05)	(0.05)
	Rural	-0.98	-0.97	-0.97
		(0.06)	(0.06)	(0.06)
N		774,809	563,664	1,056,035

Note: Hospital demand in the main sample with control function in column (1), in the sample of women who do not switch insurers and have continuous enrollment spells in column (3) and in the full sample of women in column (4). Specifications include interactions between number of beds, an indicator for bad outcomes post-delivery, and maternal mortality rate for each hospital with patient characteristics including dummies for age group, having a chronic disease, having a high-risk pregnancy, and zone of residence. Specifications also include hospital fixed effects. Bootstrap standard errors in parenthesis based on 100 resamples.

Appendix Table 5: First-Stage Estimates for C-section Pricing Functions

	FFS		Cap	
	coef	se	coef	se
Lag price	0.06	(0.02)	0.79	(1.24)
Vaginal delivery price	0.19	(0.04)	14.57	(1.77)
Vaginal delivery FFS	0.08	(0.11)	8.76	(5.33)
Markup 2	0.004	(0.002)	-116.6	(17.7)
Mean FFS price	—	—	-0.16	(0.04)
F-stat	18.45		36.07	
N	577		154	

Note: First-stage regression of Markup 1 on lagged prices and contract characteristics for other services. Specifications include insurer and municipality fixed effects. Robust standard errors in parenthesis.

Appendix Table 6: First-Stage Estimates for Vaginal Delivery Pricing Functions

	FFS		Cap	
	coef	se	coef	se
Lag price	0.10	(0.02)	-0.17	(0.63)
C-section price	0.08	(0.02)	2.96	(0.84)
C-section FFS	-0.16	(0.07)	6.74	(2.36)
Markup 2	-0.002	(0.002)	-102.4	(9.4)
Mean FFS price	—	—	-0.01	(0.03)
F-stat	18.55		8.66	
N	584		130	

Note: First-stage regression of Markup 1 on lagged prices and contract characteristics for other services. Specifications include insurer and municipality fixed effects. Robust standard errors in parenthesis.

Appendix Table 7: Health Outcome Function Estimates

	coef	se
C-section	1.67	(0.78)
FFS	6.03	(1.25)
C-section price	-0.46	(0.52)
Vaginal delivery price	-2.33	(0.70)
Age less than 30	1.96	(0.80)
Chronic disease	2.50	(0.88)
High-risk pregnancy	1.76	(0.86)
Low income	0.05	(0.83)
Rural	1.40	(1.39)
R^2	0.09	
N	7,258	

Note: Linear regression of an indicator for bad health outcomes in the month after delivery on payment contract characteristics and women characteristics. Includes hospital fixed effect. The estimation sample are women who do not switch insurers nor hospitals. Coefficient and standard errors in parenthesis are multiplied by 100 for exposition.