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Do Medicaid HMOs reduce utilization? Evidence from Florida obstetrics*

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Abstract

Using hospital discharge data, I test whether obstetricians choose primary C-sections less often for medicaid HMO patients relative to their non-HMO (medicaid) patients. I find that an HMO patient has about 40% lower odds of receiving a primary C-section, holding all else equal. This effect is heterogeneous and declines in magnitude as patient complications become more severe. In fact there is no difference in case of patients with severe delivery complications. Differences in the C-section rate are not associated with in-hospital mortality for infants. A stylized principal-agent model of physician procedure choice estimates that physicians put about 20% less weight on patient related factors for non-HMO patients relative to HMO enrollees. Finally, I also find that physicians with greater exposure to HMOs are less likely to choose primary C-sections for their non-HMO patients.

Keywords: Medicaid, HMO, managed care

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1 Introduction

State Medicaid programs traditionally set a menu of fixed provider fees for each type of service. This system, known as fee-for-service (FFS), provided a perverse incentive for physicians to perform more procedures and tests beyond what is medically appropriate. To control cost escalation and address this conflict of interest, Medicaid programs started contracting with comprehensive risk based Health Maintenance Organizations (HMOs). HMOs have a strong financial incentive to control costs since they receive a fixed premium ("capitation") from the state government for each Medicaid beneficiary they cover but have to pay providers for all health care services guaranteed by Medicaid. Risk bearing HMOs have proven very popular with state governments - they covered nearly 50% of all Medicaid enrollees in 2011, up from 30% in 2003.

This phenomenon has received significant attention in the health and economics literature. Several studies have looked at the cost and health outcomes associated with HMO expansions and found little benefit.[1] However, most studies have focused on total cost to the Medicaid program and not at specific channels of cost reduction. For example Duggan (2004) (California) and Harman et al. (2011) (Florida) find HMOs associated with higher costs in specific states. Recently Duggan and Hayford (2013) studied Medicaid program costs for all states and came to the same conclusion, although they find certain conditions under which HMOs are associated with a reduction in costs. These findings are consistent with the possibility that states have negotiated very generous capitation rates with HMOs, that HMOs do not control health care utilization, or both. Few studies have focused on identifying underlying mechanisms.

Aizer et al. (2007) study the impact of Medicaid managed care on health outcomes for infants. While their main focus is on health outcomes, they also look at related measures of care and find that mothers on managed care have 5-10% lower pre-natal interaction with physicians. A possible explanation is that HMOs mandated fewer physician visits in an effort to reduce health care costs. This is an example of cost reduction by direct controls on physician interaction or 'gatekeeping'. For evidence on other cost reduction channels we have to turn to studies on privately insured patients. HMOs have successfully cut costs in that setting primarily by negotiating lower provider reimbursements (Hillman, 1990; Felt-Lisk, 1996; Cutler et al., 2000). Since Medicaid reimbursements were already low to begin with, HMOs may not have been not able to discount them further. Another channel could be to give physicians incentives (or disincentives) to choose lower cost treatments. Gaynor et al. (2004) find that HMO-imposed financial controls on physician groups are associated with a 5% reduction in costs. In this paper I focus on this cost control channel. Specifically, I test if physicians are more likely to choose the lower cost delivery mode for obstetric patients in comprehensive risk based plans relative to those on fee-for-service plans.

Medicaid bears a substantial cost of obstetrics procedures - 43% of births in the US in

[1] See Sparer (2012) for a complete review of Medicaid HMOs. He reports that most studies finding HMOs associated with lower costs are not peer reviewed and tend to be industry sponsored.

2008 were financed by Medicaid (the corresponding figure for Florida was 44%). It is by far the most frequent reason for hospital use among Medicaid patients - mothers and newborns accounted for 45% of Medicaid discharges in Florida. It also offers a simple medical setting. While there are several decisions to be made, in terms of delivery mode there are only two choices. Physicians can perform a vaginal (normal) delivery or one by Cesarean section - a surgery. The latter typically involves higher hospital and physician fees, as well as greater hospital stay for the mother. Using the Medical Expenditure Panel Survey, I find that in 2008 the median Medicaid payment to physicians and hospitals was 19% and 45% higher respectively for a C-section. Hence in obstetrics, the choice of delivery mode is a convenient summary statistic for health care utilization.

Figure 1 shows that the mean C-section rate in Florida was about 40% in 2008, with Medicaid slightly lower than the average. The primary C-section rate is lower, around 30%.[2] The difference in the rate between HMO and non-HMO seems negligible in both private and Medicaid deliveries. However, upon excluding patients with prior deliveries by C-section, HMO patients have a 7 percentage point, or 25% lower C-section rate. In the US it is common medical practice for physicians to perform a C-section if the patient has already had one before.[3] Physicians have limited room to exercise medical judgment in cases where the patient has already had a C-section. Hence throughout the paper I prefer to focus on the decision of primary C-sections.

I estimate the association between HMO enrollment and choice of delivery mode exploiting the variation in outcomes and characteristics of HMO and non-HMO Medicaid patients that are attended to by the same physician at the same hospital. Currie and MacLeod (2013) show that variation in diagnostic and procedural expertise across obstetricians significantly affects delivery choice. Moving a physician from the 25^{th} to the 75^{th} percentile on diagnostic skill can reduce the probability of a C-section by 16% for low-risk patients. To my knowledge, prior studies on the role of managed care have not controlled for these unobservable differences across providers.

My main finding is that HMO enrollees have about 40% lower odds of receiving a C-section relative to non-HMO patients holding all else equal. This translates to a one-third lower probability of receiving a primary C-section. To interpret this as a causal effect, the key identification assumption is that unobserved medical characteristics and preferences of obstetric patients are not systematically correlated with procedure choice and HMO enrollment. I contrast this finding against the case of private insurance where both HMOs and non-HMOs operate under similar financial incentives. I find no significant difference in the likelihood of a primary C-section between HMO and non-HMO patients. I attribute these results to a determined effort by Medicaid HMOs to curb the use of C-sections. Second, I find heterogeneity in

[2] This rate is well above the 15% target set in the Healthy People 2010 plan by the US Public Health Service and it is worth investigating the reasons leading to this situation. However, for this paper the primary interest is the role of HMOs in Medicaid, with obstetrics serving as the context.

[3] 95% of patients with a prior C-section receive a C-section again.

the impact across different types of patients. The difference in C-section likelihood is greatest for low-risk patients while there is no significant difference in the primary C-section rate for patients with severe delivery complications. These results suggest that physicians focus utilization control on low risk patients. Third, and consistent with the second point above, I find that newborn infants covered by HMOs are not worse off than those on traditional Medicaid across a range of adverse outcomes.

These results provide evidence for physician agency in obstetrics and indicate that it is more severe for non-HMO patients. Other than medical need, physicians may choose C-sections due to financial incentives, personal convenience or malpractice lawsuit concerns. These differing incentives are not mutually exclusive and disentangling them is not possible without observing physician contracts. I use a stylized agency model of physician choice to quantify the magnitude of the agency distortion. Model estimates suggest that physicians place about 20% less weight on patient related factors for non-HMO patients relative to HMO patients. I also find that as a physician's Medicaid practice becomes more dependent on HMO patients she is less likely to choose primary C-sections even for her non-HMO patients. This suggests that HMOs are able to influence physician practice styles in general.

2 Setting and Data

2.1 Medicaid and Managed Care

Over the last two decades Florida has expanded the role of managed care in Medicaid. The Agency for Health Care administration (AHCA) is the designated agency that manages the Medicaid program as well as contracts with managed care insurers. Some categories of beneficiaries (like those requiring long-term care) have the option of staying in classic FFS Medicaid; however, low income families and pregnant women are required to enroll in some form of managed care. In 2008, 75% of the non-elderly adult Medicaid beneficiaries in Florida were enrolled in a managed care plan (Rowland et al., 2011).

Florida has allowed different models of Managed Care to co-exist. Within managed care, HMOs had the largest share of Medicaid beneficiaries as of October 2010, about 38% (Senate, 2010). Medipass and Provider Service Network (PSN) are two other popular models of managed care that accounted for about 25% of Medicaid enrollees. Totally about two-thirds of beneficiaries were enrolled in managed care. All three models offer beneficiaries the advantage of coordinated care with a primary physician responsible for the patient. However all of them also require referrals for specialists. The main distinction between non-HMO models and HMOs is that the latter assume insurance risk for the beneficiaries. In return for a fixed premium or capitation amount per beneficiary per month, the HMO undertakes to pay for all the services guaranteed by Medicaid.

Beneficiaries have the option of enrolling with an HMO or another form of managed care. If they don't exercise their choice within 30 days, they are then randomly assigned to an

HMO.[4] Medicaid guarantees that all beneficiaries will receive the same health coverage and incur the same cost-sharing, regardless of their health plan. Hence beneficiaries do not have a financial incentive to choose one type of coverage over another. Personal preferences over network quality and convenience are likely driving choice of plan. I discuss other possible motivations in the identification section.

HMOs receive age-bin specific premiums from the state. But these are not risk adjusted and hence HMOs have an incentive to enroll healthy beneficiaries. Recognizing this challenge, Florida has imposed strict regulations on HMOs to avoid risk-based selection.[5] At the same time, HMOs have limited avenues of positively selecting perceived low-risk beneficiaries under the terms of their contract. The contract states that they "cannot offer monetary or other valuable consideration" for enrollment to any beneficiary (AHCA, 2013). Further the contract specifies the type of marketing materials that the HMO can produce and distribute to beneficiaries. However, we could still be concerned that HMOs have identified ways to get around these regulations and enroll healthier individuals.

There are some institutional features of the program that predict adverse rather than advantageous selection by HMOs. First, several HMO enrollees are defaulted in - which indicates they could be worse off than the average beneficiary. Second, several HMOs offer additional benefits like preventive dental/vision packages, vaccinations, OTC medicines, post-discharge meals as well as provider home visits at no cost - which are not available in other forms of managed care (as examples see Amerigroup (2014); Humana (2014)). These types of features are more attractive to beneficiaries who suspect they are high risk. Reinforcing the possibility of adverse selection, Medicaid HMOs have a higher proportion of black enrollees relative to non-HMOs. Kuziemko et al. (2013) describe at length that blacks form a higher risk obstetric patient group relative to hispanics and whites. In the data I find that HMO patients are more likely to have co-morbidities and delivery complications.

2.2 Obstetrics

Labor and delivery provides a suitable context to investigate the role of physician agency under different insurance regimes. First, physicians have two substitutable delivery options to choose from, and several conditions under which there is no consensus on the 'right' choice. Hence physician judgment plays an important role, is difficult to review, and is usually not reviewed. There are some conditions that are detectable before the onset of labor that necessitate C-sections and these result in so-called "scheduled C-sections" (for example, multiple gestation). The physician and patient agree in advance that a vaginal delivery is not safe. Some complications occur during labor and also necessitate C-sections (for example Placenta

[4]Unfortunately, I do not observe this assignment. I recognize that for this sub-group the endogenous enrollment issue is less troublesome.

[5]They cannot reject Medicaid beneficiaries based on any demographic trait (race, ethnicity, gender, age), prior medical history or pre-existing conditions. Only administrative reasons are permissible, for example if the beneficiary provides false information or refuses to provide the necessary information.

Previa).[6] However there are still other conditions under which the procedure choice is left to the physician's judgment. For example, the public health literature (Cunningham et al., 2010; Gleicher, 1984) identifies two conditions that are highly correlated with C-sections, and may be mis-diagnosed or misused to justify C-sections. One is Dystocia, which is difficult or prolonged labor, and Fetal Distress, when the fetus suffers from low oxygen supply. For a comprehensive review, see Shearer (1993).

Second, typical patients receiving a primary C-section are highly likely to accept the physician's recommendation on delivery procedure. A nationally representative survey of mothers in 2005 (40% of whom were on Medicaid) found that 88% of mothers who had a primary C-section agreed to it due to the physician's recommendation vs. 10% who decided on their own (Declercq et al., 2006) (Figure 6). This setting allows non-medical factors like financial incentives and convenience to influence the decision and yet be plausibly denied. Several studies on procedure choice in obstetrics have also come to this conclusion (for example, see Currie et al. (1995) and Gruber and Owings (1996)). In fact physician decision-making is influenced not only by HMO controls but also by hospital incentives. Foo et al. (2013) find that a $1,000 increase in hospital reimbursement is associated with a 1.1 percentage point increase in the use of C-sections. In addition there is a rich strand of literature linking physician convenience with the choice of a C-section (summarized in Brown III (1996)).

Third, typical reimbursement schemes provide financial incentives favoring C-sections. Both physicians and hospitals receive a larger payment if a C-section is performed instead of a vaginal delivery. Gruber et al. (1999) point out that the costs for physicians at least are similar across the two modes of delivery, in fact arguably they are somewhat lower for C-sections.

2.3 Data

I use confidential hospital discharge data for 2008, provided by the Florida AHCA. This provides information on the universe of discharges at all non-federal short term care hospitals in Florida. Hospitals are legally mandated to collect case information and provide it to the state. This data is different from what they submit to the (insurance) payer for reimbursements. Hence measurement error (for example in recording patient co-morbidities and demographics) is likely to be orthogonal to the patient's insurer and procedure. This is a key advantage over using insurer claims data where coding error could be confounded by financial incentives.

Each observation in the data represents a hospital inpatient case. It provides information on patient demographics and location (race, age, gender, zipcode), diagnoses (up to 30), procedures performed (up to 30), list prices charged by the hospital, insurance type, and the physician involved (both attending and operating). I identify about 105,000 Medicaid deliveries in this data. I drop minimal observations to prepare the data for analysis - cases with missing data, where the patients' home county is outside Florida, transfer cases, outliers on

[6] The UK National Health Service mentions a list of conditions that make C-sections medically necessary. Available at http://www.nhs.uk/Conditions/Caesarean-section/Pages/Why-is-it-necessary.aspx

the basis of length of stay in the hospital and deliveries performed by nurses. The final data set has 96,560 deliveries.

The data also allows me to identify infants born in the hospital and covered by Medicaid. Using the same sample restrictions I identify about 103,000 infants. The data does not provide patient identifiers or dates and hence I cannot link infants to mothers. To test the association between infant outcomes and delivery choice, I analyze trends at the hospital level.

3 Empirical Strategy

3.1 Estimating equation

The main hypothesis is that HMO controls (whether financial or not) may influence physicians to choose lower cost vaginal deliveries for their HMO patients relative to non-HMO patients. I assume a simple linear in variables latent utility model where physician i receives unobserved indirect utility c^* from choosing a delivery procedure (c) for patient k in hospital j. I assume that

$$c^*_{ijk} = \alpha\mathbf{1}(\text{HMO})_k + \boldsymbol{\gamma}\mathbf{X}_k + \delta_{ij} + \epsilon_{ijk} \tag{1}$$

and

$$c_{ijk} = \begin{cases} 1 & \text{if } c^*_{ijk} \geq 0 \\ 0 & \text{if } c^*_{ijk} < 0 \end{cases} \tag{2}$$

A C-section is denoted by $c = 1$, while a natural delivery is the baseline choice. $\mathbf{X}_k$ is a vector of patient characteristics (race, 5 year age bins, indicators for pregnancy related medical conditions and interactions) and a constant. δ_{ij} represents an unobserved fixed effect for the relationship between hospital j and physician i. In alternate specifications I include only physician fixed effects δ_j and find very similar results. $\mathbf{1}(\text{HMO})_k$ is an indicator variable set to 1 if the patient is enrolled with a Medicaid HMO and 0 otherwise. α is the coefficient of interest, it captures the change in probability of receiving a C-section associated with HMO enrollment.

ϵ_{ijk} accounts for case specific random shocks to treatment choice and is assumed to be a standard logit error term. I use a conditional logit specification so that the fixed effects δ_{ij} are eliminated before estimation.

3.2 Identification

The key identifying assumption is that after conditioning on observed medical conditions, Medicaid obstetric patients have no unobserved preferences or conditions that are correlated with their enrollment with an HMO and which affect the delivery procedure choice. This restriction enables a causal interpretation of α. The use of hospital-physician dyad fixed effects relaxes the assumption imposed on physician preferences. Not only does it allow for unobservable physician preferences over procedure choice, but also it allows these preferences to vary by hospital. Hence the same physician can prefer C-sections at one hospital and vaginal deliveries at another hospital.

There are two main concerns with this assumption, given that Florida's Medicaid program allows beneficiaries to choose an HMO or another managed care plan operating in the county. First, I rule out the possibility that beneficiaries choose to enroll with an HMO because they prefer a non-surgical delivery. This is an untestable restriction, but I believe a reasonable one. Declercq et al. (2006) (Table 10) report that only 2% of mothers who had a primary C-section did so without a medical reason. This indicates that nearly all mothers undergo primary C-sections only when required. Further, for beneficiaries to strategically enroll in HMOs to avoid C-sections they would have to know at the time of enrollment that Medicaid HMOs have a lower probability of primary C-sections for marginal patients and expect that they could be a marginal patient. This possibility seems remote.

Second, we might be worried that enrollment choice is an endogenous outcome of HMO recruitment effort. As discussed above, HMOs have an incentive to enroll healthier beneficiaries. This would mechanically produce the hypothesized result. Studies that have looked at selection of healthier individuals by HMOs have found mixed results. Cardon and Hendel (2001) and Breyer et al. (2012) find no evidence of advantageous selection while Glied et al. (1997) found that Medicaid HMOs in New York City were able to recruit healthier enrollees. In section 5 I subject the baseline results to several robustness checks to assuage these concerns as best I can.

4 Results

4.1 Summary statistics and initial evidence

Table 1 presents summary statistics from the set of approximately 80,000 Medicaid patients that have not had a prior delivery by C-section. All the results presented in the paper are based off this group of patients. Panel A compares HMO and non-HMO patients on health indicators and demographics while Panel B summarizes the procedure choice of physician grouped into three bins based on whether they performed deliveries for HMO, non-HMO or both types of (Medicaid) patients.

4.1.1 Health indicators

I use several indicators to gauge the severity of co-morbidities in patients. First, I use severity ranks presented in Ho and Pakes (2014), defined by obstetrical experts at Columbia Presbytarian hospital. They assign a severity rank of 1,2 or 3 to about 200 co-morbidity conditions that could affect a patient at the time of delivery. A rank of one denotes a routine condition (examples include headaches, nutritional deficiencies), two indicates a moderately severe condition (uncomplicated Diabetes), while three indicates a severe condition (different types of cancer, Hypertension with complications). The full list of conditions and severity ranks is available in their online Appendix 4. The table shows the assignment of patients into categories defined by the highest severity rank for a diagnosed co-morbidity. The distribution is similar across the two groups, though the differences in means are statistically significant. HMOs have a lower proportion of severity 1 cases ($p < 0.01$) and higher proportion of cases with severity 2 ($p = 0.37$) and 3 ($p < 0.01$). Panel A of Figure 2 presents the distributions using a more detailed categorization following Ho and Pakes (2014), but these also look similar.

Next I present leading indicators of health. Ideally these should simulate the type of information the HMO can observe at the time of enrollment. I assume this is well before the actual delivery occurs, hence the indicators should not factor in diagnoses related to labor or to fetal anomalies. I propose two such indicators. First is the patient's Charlson Co-morbidity index. This is a weighted count of diagnoses[7] designed by Charlson et al. (1987) to predict ten year mortality. The Charlson score was not designed specifically for obstetrics, but has been applied by previous literature to obstetrics. To provide a more targeted indicator I construct a signal of a likely routine delivery using a subset of requirements that the Florida Medicaid program has stipulated to define a delivery as "High risk". I compute this indicator based on information observable at the beginning of a pregnancy term. I present the conditions that define a high risk as well as 'routine' delivery in appendix table A.1.

HMO patients signal marginally higher risk based on the indicators discussed above. They are more likely to have a higher Ho-Pakes severity rank, Charlson score as well as a non-routine delivery.

4.1.2 Demographics

Table 1 Panel A shows that there is a large difference in racial composition across the two groups. HMO patients are much more likely to be Black and less likely to be Hispanic than are non-HMO patients. In general, HMO patients are more likely to be from a minority group and this is potentially driving the higher incidence of teenage pregnancy in the HMO group. Nationally, Blacks and Hispanics have double the teenage pregnancy rate of other groups and Blacks have a higher C-section rate than do Whites and Hispanics.[8] In Florida, there is no such disparity in the proportion of C-sections across Blacks and Hispanics.[9]

Clearly, the HMO and non-HMO patient groups have different demographic features. The baseline specifications will control for these with the implicit assumption that if there are unobserved features correlated with demographics (and hence different for the two groups)

[7]The conditions are Acute Myocardial Infarction, AIDS/HIV, Cancer, Cerebrovascular Disease, Chronic Pulmonary Disease, Congestive Heart Failure, Dementia, Diabetes with chronic complications, Diabetes without complications, Hemiplegia or Paraplegia, Metastatic Carcinoma, Mild Liver Disease, Moderate or Severe Liver Disease, Peptic Ulcer Disease, Peripheral Vascular Disease, Renal Disease, and Rheumatologic Disease (Connective Tissue Disease).

[8]Source: CDC, available at http://www.cdc.gov/features/dsteenpregnancy/ and in Table 22, http://www.cdc.gov/nchs/data/nvsr/nvsr59/nvsr59_01.pdf

[9]Excluding cases with prior C-sections non-Hispanic Whites have a C-section rate of 28%, non-Hispanic Blacks have a rate of 28% and Hispanics have a rate of 30%.

then these are not correlated with HMO enrollment and delivery procedure choice. Given that the HMO patient group has a higher share of traditionally disadvantaged communities it is reasonable to expect that any such unobserved differences (for example, in quality of prenatal care) are likely to bias the effect toward zero.

4.1.3 Physicians

Table 1 Panel B summarizes the mean primary C-section rate for physicians, showing the results separately for three groups of physicians. These groups are defined by whether the physician performs deliveries only for Non-HMO, only HMO or both types of Medicaid patients. Note that about 60% or approximately 900 of the 1,545 physicians treat both types of patients. There are very few physicians that treat only HMO medicaid patients and they account for a minuscule proportion of patients. Physicians that treat both types of patients have a much larger practice size than the average and account for more than 90% of the patients in the sample. Note that α is identified using variation within physicians that deliver babies for both HMO and non-HMO patients. The average physician who treats both types of patients performs deliveries for about 10 HMO patients and 70 non-HMO patients. Note that these statistics exclude cases where the mother has already had a C-section. If we consider all cases for the type 'Both' physicians, they deliver for about 15 HMO and 80 non-HMO patients.

Appendix B documents the differences across physicians that treat privately insured and Medicaid obstetric patients. I also analyze differences within these two broad categories depending on whether the patient is covered by an HMO or non-HMO. One key finding is that physicians that treat Medicaid patients are quite similar regardless of whether they treat HMO or Non-HMO patients. However, physicians that treat Medicaid patients are quite different than physicians that treat privately insured patients. Medicaid and privately insured patients are unlikely to see the same physician.

4.1.4 Infant outcomes

Figure 3 panel A presents raw frequencies of several different adverse outcomes for newborn infants covered by Medicaid. These outcomes were identified using primary and secondary diagnosis codes. The chart shows the frequencies separately for HMO and non-HMO newborns and by the type of delivery. Prior studies have typically looked at mortality as the main health outcome of interest. In-hospital mortality is thankfully a very rare outcome affecting less than 0.5% of infants and only a third of the hospitals in this setting. Hence I also consider other outcomes that are commonly associated with the type of delivery. Appendix table A.2 presents summary statistics about infants, including racial composition and other characteristics that are unrelated to the type of delivery (eg: low birth weight, congenital defects). The raw frequencies indicate that newborns covered by HMOs suffer these adverse events at rates that are less than or similar to those for non-HMO newborns across both types of deliveries.

4.2 Choice of delivery procedure

Table 2 Panel A presents results from estimating equation [1]. I present 5 specifications - all excluding patients who have had prior C-sections. Column 1 presents results without employing any fixed effects and follows the same specification as used in Gruber et al. (1999). Columns 2 & 3 estimate within physicians, while columns 4 & 5 estimate within a hospital-physician dyad. While we benefit from better identification by controlling for unobserved physician skill and preferences, we also sacrifice the variation from cases for those physicians that only see HMO or non-HMO patients. Column 2 onward I use the main specification from Foo et al. (2013), adding indicators to control for maternal distress and obesity. I refer to this as the base specification. Column 3 onward I further exclude all scheduled C-section cases, as well as patients who have a history of hypertension or diabetes. Estimating within a hospital-physician dyad avoids the problem of unobserved physician preferences that vary by hospital (maybe due to variation in hospital policies or infrastructure). In column 4, I also condition on leading indicators of patient health. Finally in column 5, I include interactions of HMO enrollment with pregnancy complications to check if HMO enrollment differentially impacts patients with pregnancy complications.

Across all columns, the odds of an HMO enrollee having a C-section are about 40% lower than if she were to be not with an HMO. Including fixed effects does not alter the estimate value materially. Excluding scheduled C-sections does not make much difference either. It is also not sensitive to switching from estimating within physicians to within physician-hospital dyads. Conditioning on leading health indicators also does not affect the estimate. Overall, these results confirm what we saw in the raw data; HMO patients are less likely to undergo C-sections holding all else equal. Another interesting aspect of the results is the association between hospital ownership/mission and physician procedure choice. The odds of a C-section are substantially lower in a teaching hospital relative to non-teaching non-profit hospitals and marginally statistically significant. The odds of a c-section are higher in an investor-owned (for-profit) hospital. These results are consistent with prior literature on this topic (for example, Gruber et al. (1999)).

In column 5 I control for an additional complication - Dystocia, which was mentioned earlier as a condition often mis-diagnosed and allegedly misused to justify C-sections. Dystocia is a condition of prolonged labor. The coefficient on the interaction of HMO enrollment and Dystocia is significant and equal to 0.74 indicating that the odds of a HMO patient suffering from Dystocia undergoing a C-section are 25% lower than for non-capitated patients with Dystocia. At the same time the coefficients on other conditions like obesity, older age and maternal distress are not lower for HMO patients. In fact, in case the patient is in distress, the odds of a C-section for HMO patients is twice that for non-capitated patients.

4.3 Infant outcomes

Table 2 Panel A shows that physicians choose primary C-sections less often for HMO patients relative to non-HMO patients within Medicaid. While this undoubtedly reduces utilization of health care, an important concern is whether this cost control adversely affects the health of mothers and infants. More specifically, the concern is that physicians may be limiting C-sections even for mothers that would benefit from them. Assuming that physicians choose C-sections appropriately according to medical need for non-HMO patients, this implies that mothers and infants on HMO plans who do not receive necessary C-sections will be worse off than their non-HMO counterparts.

I cannot link mothers and infants and hence cannot test this hypothesis directly. However in order to speak to this concern I analyze equivalent trends at the hospital level.[10] The implication of worse outcomes for HMO patients at the physician level can be tested in aggregate at the hospital level (though not as rigorously). I first obtain the risk-adjusted differential (between HMO and non-HMO medicaid deliveries) primary C-section rate by estimating equation [1] at each hospital separately using a linear probability model. This is equivalent to α from [1]. Under the assumption that C-section decisions are taken appropriately for non-HMO patients, these differential values represent the average magnitude of the distortion for HMO patients at each hospital. Next I estimate the risk adjusted differential frequency (between HMO and non-HMO medicaid infants) of different adverse infant outcomes Y_i at each hospital using the following specification.

$$Y_i = \beta 1(HMO) + \delta_j + \boldsymbol{\gamma}_2 \boldsymbol{X}_i + \epsilon_i \tag{3}$$

δ_j represents a fixed effect for the attending physician j associated with infant i. $\boldsymbol{X}_i$ is a vector of patient level indicators for different conditions that could affect the outcomes. I do not control for the mode of delivery (C-section or not) since that is the endogenous choice in question here. In the final step I test the correlation between these two objects - α and β - using weighted least squares regression on the cross-section of hospitals.

Figure 3 Panel B presents a scatter plot of these two estimated values for all 113 hospitals in the data.[11] For all four conditions, most hospitals lie in the third quadrant i.e. the risk adjusted primary C-section rate is typically lower for HMO patients and the risk adjusted frequency of outcome is also lower for HMO infants. This is consistent with the raw frequencies at the aggregate level seen in figure 1 and figure 3 panel A. The chart also mentions the slope coefficient from the cross-section regression. The slope coefficients are uniformly noisy due to the small sample sizes however the magnitudes are small and the coefficient signs suggest that as the C-section rate for HMO patients moves closer toward that of non-HMO patients, adverse outcomes for HMO infants become *more* likely. Let's consider the case of mortality. A hospital where the difference in C-section rates between HMO and non-HMO patients is higher (less

[10] I cannot even analyze at the physician level since the physicians associated with deliveries are obstetricians while those associated with newborn infants are typically pediatricians.

[11] I tried a variant of this estimation limiting the sample to hospitals that delivered at least 350 Medicaid infants and obtained similar results.

negative) by 4 percentage points (which is more than half the mean difference in the overall data), expected mortality for HMO infants is higher by 0.00004 ($0.001 * 0.04 = 0.00004$). This is equivalent to less than 5% of the mean mortality rate for HMO infants (0.0012). Other coefficients have interpretations of similar scales. This simple analysis suggests that infant outcomes for HMO patients are not worse relative to non-HMO patients and not correlated with the choice of C-sections, at least at the hospital level.

5 Robustness

In this section I first present a couple of results in the spirit of falsification. I do not exploit a specific policy change hence there is no natural avenue for falsification. However, I try to replicate the above results in settings where we should not expect to find them. I then present results estimated for specific sub-groups of patients to rule out alternate explanations.

5.1 Private insurance

The premise of this paper is that HMOs will respond to the fundamentally different financial incentives that they operate under, relative to fee-for-service Medicaid. It is often overlooked that this stark difference in financial incentives does not exist in private insurance. In fact, Medicaid HMOs operate in a unique context, distinct from both private insurance and Medicare. Private insurers always bear the risk of health coverage for their members, whether they are enrolled in HMO, Preferred Provider Organization (PPO) or Point-of-Service (POS) plans. Medicare advantage plans are often seen as equivalent to Medicaid HMOs, however they benefit from risk adjusted premiums and substantial cost sharing on the patient side.

While HMOs have proven themselves to be more cost effective than other forms of managed care in the private space, all models operate within the same financial framework i.e. they are liable to cover potentially unlimited costs of health care services for patients while they receive a fixed premium per beneficiary per month . Moreover, privately insured patients are more likely to be older, college educated and assertive than their Medicaid counterparts. For these reasons we should expect that physicians will not be required to and be unable to differentiate substantially between privately insured HMO and non-HMO patients. Table 2 Panel B presents the equivalent results of estimating equation [1] on the corresponding sample of privately insured patients. Across all columns, HMO patients have similar odds of receiving a primary C-section as non-HMO patients. In most cases, the coefficient is not statistically significant. Appendix table A.3 presents summary statistics on private patients, equivalent to Table 1 Panel A.

This result also suggests that there is nothing intrinsic about HMO operating procedures that produces a lower C-section rate. This stark difference in the results of Panel A and B of table 2 is more noteworthy in light of the fact that most large commercial HMOs operating in Florida also offered Medicaid HMO plans (Baumgarten, 2011). I take these results to imply a deliberate focus on reducing the incidence of primary C-sections among Medicaid HMO patients.

5.2 Patients with delivery complications

So far I have explicitly excluded cases with delivery complications associated with C-sections since I wanted to focus on cases where physicians have room to exercise medical judgment. However these cases can offer a plausible setting for falsification. Assuming the physicians base their decision primarily on the patient's best interest, financial incentives will not affect their decision for non-marginal patients. Hence in the case of patients with delivery complications we should expect to see little or no difference in the primary C-section rate between HMO and non-HMO patients after accounting for physician heterogeneity. Panel 1A of Table 3 shows the mean C-section rates for patients with different pregnancy conditions that have been listed by the UK National Health Service as medical reasons to receive a C-section and are identifiable in the data. The mean C-section rate is statistically indistinguishable between HMO and non-HMO patients for all conditions except prior C-sections (where it is marginally significant). For this condition, HMO patients have the higher rate. Panel 1B of Table 3 presents results by estimating specification 4 for cases with each of these conditions. The estimate $\hat{\alpha}$ is either close to 1 or greater than 1 across conditions. Odds translate to higher probabilities, so the predicted probabilities are even closer for the two groups. The estimates naturally lose power due to smaller sample size, but estimates close to one suggest that there is little or no effect for these patients with clear medical need for C-sections.

5.3 Specific patient groups

5.3.1 Co-morbidity

We might be concerned that differences in the distribution of patient co-morbidity severity (see figure 2 panel A) across HMOs and non-HMO are biasing the results. For example, HMOs may not be affecting procedure choice at all; rather, compositional differences in the patient population are producing this average effect. To address this concern, columns 1, 2 and 3 of Table 3 Panel B split the population into three groups based on the rank of the most severe co-morbidity condition. Recall that these ranks were assigned specifically for obstetric cases. I then estimate specification 4 from Table 2, but within these sub-samples. I find that the sub-sample estimates for patients having a maximum severity rank of 1 or 2 are similar to those in the main results. For the patients of the highest severity rank, the HMO effect is substantially smaller (though not statistically significant different). This is consistent with the interpretation that HMOs are focusing cost-cutting on the routine patients.

5.3.2 Experienced patients

An implicit assumption has been that the physician decides which procedure to perform based on her own judgment. However, some patients will be more assertive about what type of delivery they would like to have. Johnson and Rehavi (2013) showed that more informed patients (physicians) have substantially different primary c-section rates than non-physician patients, both in an HMO setting and outside. In such cases the obstetrician will have limited or no discretion. If better informed patients sort into HMOs it may lead to omitted variable bias.

A plausible cause for asymmetric information is prior personal experience. Based on prior experience with childbirth, a patient can have a well-founded prior about which procedure is more desirable. Ideally, I would estimate the preferred specification on the set of first-time patients in order to address this concern. Unfortunately I cannot reliably observe if a patient is delivering for the first time. Instead, I use a crude work-around based on an age cutoff. The CDC reports that the mean age of mothers at first birth in Florida was 25.[12] Given the long tail in the age distribution (20% of the Medicaid obstetrics patients are over the age of 30), by construction this implies that a majority of patients under 25 must be delivering for the first time. Column 4 of Table 3 Panel B replicates the result for the set of patients who are younger than 25. The estimate for this group is reassuringly similar to what we obtained in the baseline results.

6 Physician decision model

In section 4.2 I find that HMO patients have about a one-third lower probability of receiving a C-section relative to non-HMO patients. Baicker et al. (2006) report that C-sections cost about $6,200 more than a vaginal delivery. Moreover women are at a higher risk of follow-up complications if they undergo a C-section. So the expected cost difference is higher than this figure. These results imply that Medicaid HMOs are reducing the proportion of C-sections and associated health care costs.

Another finding of interest is that physicians' treatment choices are affected by the nature of the hospital. Physicians are less likely to choose C-sections in a teaching hospital relative to a for-profit hospital for both HMO and non-HMO patients. This suggests that hospitals also influence physician treatment choices.

A major extraneous factor to consider is financial incentive. Two types of financial incentives could be operating on the obstetrician simultaneously. For example, HMO financial and institutional controls reward physicians if they limit their own and hospital billing. In the extreme, obstetricians could be denying patients medically necessary C-sections. At the same time, obstetricians may be performing medically unnecessary C-sections for non-HMO patients to receive monetary rewards and/or intangible benefits from hospitals. These two in-

[12]Source: CDC 2006, available at http://www.cdc.gov/nchs/data/databriefs/db21.pdf

centives are not mutually exclusive and unfortunately cannot be disentangled without data on the physician-HMO contracts. In addition, convenience could affect procedure choice independent of financial incentives. This has received much attention in the popular media (as an example see Rosenberg (2014)). C-sections are undoubtedly more convenient for physicians since they have a well-defined timeline and take less time than natural deliveries on average (Spetz et al., 2001). Since I don't observe differences in duration of labor or the admission dates of cases, I cannot separately identify the role of convenience from financial incentives. The empirical results suggest that physician agency is more severe in case of non-HMO patients. Next, I use a stylized model of physician decision making to quantify by how much.

6.1 Stylized model

Physician i in hospital j has to choose procedure $c = 0$ (normal delivery) or $c = 1$ (C-section) for patient k. The physician has to make a trade off between weighting patient related factors[13] and her own private benefit. $\beta \in [0, 1]$ is the parameter that determines the weight the physician puts on patient related factors. Indirect physician utility from a C-section takes the form

$$U^{phys} = \beta[\boldsymbol{a}\boldsymbol{X}_{1k}] + (1-\beta)\mathbb{E}[\pi_{ijk}] + \epsilon_{ijk}, \tag{4}$$

where

$$\mathbb{E}[\pi_{ijk}] = \gamma_j + \boldsymbol{b}\boldsymbol{X}_{2k} + \boldsymbol{c}\boldsymbol{Z}_{ij}$$

For the purpose of this simple model, let all patient factors relevant to the choice of procedure be summarized by her race, age and delivery related co-morbidities, encapsulated in $\boldsymbol{X}_1$. Note there is essentially no cost sharing in Medicaid, so procedure price is not a relevant factor for patients. This exercise also assumes that patients accept the physician's recommendation. Hence the observed procedure reflects the physician's decision. The only scenario explicitly ruled out is that the patient chooses a delivery procedure against the wishes of her physician. In practice, this is rarely observed.

The physician's private benefit π_{ijk} has a level set by the fixed effect γ_j for hospital j. This embodies unvarying characteristics of the hospital which may affect the treatment decision. Some hospitals have more readily available surgery rooms for C-sections and/or have more relaxed norms to justify C-sections. Alternatively it captures a mix of the effect of convenience and hospital policy. $\boldsymbol{X}_2$ is a vector of patient characteristics that could interact with the physician's private motive (say, convenience or ease of justification) and procedure choice. For example, race is excluded from $\boldsymbol{X}_2$ since it is assumed irrelevant to the procedure choice decision after conditioning on medical factors.

The physician's private benefit also depends on features of her practice and relationship

[13] A richer model could incorporate the unborn child as a third stakeholder in this decision. However I cannot link infants and mothers that would allow me to estimate such a model credibly.

to the hospital ($\boldsymbol{Z_{ij}}$).[14] I introduce two features using a reduced form approach. The first is the share of the physician's deliveries funded by HMOs. If HMO controls encourage reducing utilization (the central hypothesis of this paper), then a greater share of HMO deliveries should make these controls more salient and hence be associated with a lower probability of C-sections. The second measure is the share of the physician i's deliveries performed at hospital j. This indicates the importance of hospital j to the physician's practice. Potentially, higher the share of the hospital, greater is its leverage over a physician and ability to influence her choices. Under this hypothesis, a higher share will be associated with a higher C-section probability.

The error term ϵ_{ijk} accounts for unobserved shocks not related to the physician's private benefit that might affect procedure choice. A typical example includes patient specific hospital capacity constraints related to labor rooms, medical staff or medical equipment that influence procedure choice but do not affect the patient or physician's value from choosing a particular procedure.

6.2 Estimation and Identification

The parameter of interest in this simple model is β. I allow β to be different for HMO and non-capitated patients i. e. β_H and β_F respectively. This allows the physicians to put different weights on patient factors depending on whether the patient is HMO funded or non-capitated.

The challenge in this exercise is to estimate the βs separately from the coefficients of patient factor $\boldsymbol{X}_1$ and physician's private benefit π and so I need to make two simplifying assumptions. First, I set $\beta_H = 1$ and estimate β_F under this constraint. The assumption is that HMOs have eliminated physician agency by employing a set of financial controls. Physicians choose the optimal procedure for their HMO patients only considering patient factors. The estimate $\hat{\beta}_F$ then actually represents the ratio β_F/β_H. Second, I constrain $\boldsymbol{X}_1 \neq \boldsymbol{X}_2$. This rules out the possibility that the physician's private benefit considers all of the elements that the patient cares about. Specifically, since I exclude race from $\boldsymbol{X}_2$, this approach does not allow physicians to derive some private benefit from choosing C-sections purely based on race. In principle, this is a weak restriction. Equation 4 now takes the following form

$$U^{phys} = \begin{cases} \boldsymbol{aX}_{1k} + \epsilon_{ijk} & \text{if HMO} \\ \beta_F[\boldsymbol{aX}_{1k}] + (1-\beta_F)[\gamma_j + \boldsymbol{bX}_{2k} + \boldsymbol{cZ}_{ij}] + \epsilon_{ijk} & \text{if non-HMO} \end{cases} \tag{5}$$

The parameters are estimated using both HMO and non-HMO patient observations jointly. From HMO patients, we directly estimate coefficients of the patient related factor that enter $\boldsymbol{a}$. This allows β_F to be estimated off of the non-HMO patient observations since $\boldsymbol{aX}_1$ is known. Observe that the restriction $\boldsymbol{X}_1 \neq \boldsymbol{X}_2$ ensures β_F is identified; otherwise it would not be possible to separate β_F from $\boldsymbol{b}$. The remaining coefficients are identified since β_F is known.

[14]The specification is flexible and one can allow for interactions between patient factors $\boldsymbol{X}_2$ and elements of the physician's practice Z

If $\hat{\beta}_F < 1$, it indicates that physicians put more weight on private benefit for their non-HMO patients relative to their HMO patients.

To proceed with estimation, I assume ϵ_{ijk} is a logit error and estimate using maximum likelihood.

6.3 Results

I present estimates of β_F using 3 different specifications in Table 4. These are variants of the model presented in equation 4. Column 1 is the basic specification without including hospital fixed effects. Specifications in columns 2 & 3 include a vector of indicators for hospitals. The preferred specification is in column 3, and it controls for a vector of medical condition interactions. Across models, the estimator is precisely estimated with a p-value close to zero. The estimates range from 0.57 to 0.83. Inclusion of hospital fixed effects dramatically increases the estimated value of β in column 2. Additional controls do not affect the estimated value.

In all specifications I include two measures of the physician's practice that relate to financial incentives (described in section 6.1). The coefficients in column 1 shows that the coefficient on % hospital share of deliveries does not have the expected sign. However, once we estimate within hospitals, we get the expected sign. Higher HMO share of a physician's Medicaid deliveries is associated with a lower probability of C-sections; and the opposite is true for the hospital's share of physician deliveries. The coefficient on HMO share of Medicaid deliveries is statistically significant at the 10% level and economically significant. A 5 percentage point increase (which is the median standard deviation of HMO share of Medicaid deliveries across quarters for physicians) in the HMO share of Medicaid deliveries of the physician is therefore associated with 20% lower odds of a primary C-section for her non-HMO patients. Given that the mean primary C-section rate for non-HMO patients is approximately 28%, a 20% reduction in odds translates to a 15% reduction in the probability of a primary C-section. The coefficient on % hospital share of deliveries is not statistically significant. A 1 percentage point increase in the hospital's share of the physician's deliveries is associated with a 1% increase in the odds of a primary C-section.

Next, I investigate how this distortion affects the choice of delivery for different types of non-HMO patients. I set $\beta = 1$ for non-HMO patients to simulate a policy of mandatory HMO enrollment for all Medicaid beneficiaries. Figure 4 presents the impact of this counterfactual exercise on predicted C-section probability by race, age group and severity bins, respectively. In all figures, the dashed line indicates the median impact for the whole sample, around 6 percentage points. Panel A shows that the results do not vary much by race. This is intuitive since conditional on age and medical conditions, race should not affect the choice of obstetric procedure. There are two noteworthy observations on Panel B. First, teenage patients are slightly more likely to receive a C-section if they are HMO enrolled. Second, the impact of HMO enrollment declines as patients age - it disappears for patients older than 35. Panel C shows the impact of HMO enrollment for patients in different severity bins. There is a mild upward trend indicating that the impact of HMO enrollment decreases as a patient's condition becomes more complex.

6.4 Discussion

The results above show that physicians distinguish between their HMO and non-HMO patients in an economically significant way. They weight patient related factors about 20% less in case of non-HMO patients. There is a large increase in the estimated β_F when we include hospital fixed effects in the physician's private benefit. I interpret this to mean that some of the impact of hospital policies or culture was being attributed incorrectly to physician agency in the results in column 1. The current approach of including features of the physician's practice in the private benefit vector is a simple first step towards understanding the role of financial incentives. These estimates suggest that the nature of the physician's practice affects her procedure choices which is consistent with a financial incentive hypothesis. The estimates suggest that as a physician's exposure to HMO controls increases she is less likely to choose C-sections even for her non-HMO patients. So HMO controls can shape the physician's overall practice style. The results also suggest that hospital incentives do not matter to physician decision making. However the lack of variation in the underlying data (only a quarter of physicians actually perform deliveries in more than one hospital) is also a driving factor in producing this noisy estimate.

7 Conclusions

Prior literature on the role of HMOs in Medicaid has produced mixed evidence on whether they help reduce costs. There is also little evidence on the channels used by HMOs to affect costs since they focus on aggregate cost. This paper investigates whether HMOs reduce health care utilization in Medicaid by influencing physicians to choose lower cost treatments. I use Florida obstetrics as a case study. The choice of a C-section is a convenient summary statistic that indicates higher health care utilization and cost. I find that HMO enrollees have about 35-40% lower odds of receiving a primary C-section relative to non-HMO patients, holding all else equal; equivalent to approximately one-third lower probability of receiving a primary C-section.

This result is remarkably robust to varying the specification, as well as focusing on different patient groups. To interpret this causally, I make the identifying assumption that unobserved patient preference for C-sections is not systematically correlated with their decision to enroll in an HMO plan. I do not find any effect when I specifically consider cases where C-sections are medically necessary. This suggests that physicians are able to limit utilization for the more routine cases. I also find no effect between HMO and non-HMO patients in private insurance, suggesting that HMOs do not necessarily always produce lower C-section rates.

A stylized model of physician utility from procedure choice finds that physicians put 20%

less weight on patient related factors for non-capitated patients, relative to HMO patients. The nature of the physician's practice - specifically, elements that would make the HMO or hospital's financial incentives more salient - also affect her practice style, with signs in the hypothesized direction. An increase in the HMO's share of the physician's Medicaid deliveries is associated with a lower C-section rate for her non-HMO Medicaid patients.

This paper used obstetrics as a case study, but I expect these results to hold qualitatively for other medical conditions where physicians can choose between substitutable procedures (for example, heart attacks). Differences in Medicaid regulation will affect HMO incentives, provider behavior as well as our ability to measure this response. The general principle of HMO plans serving a patient population with a different set of incentives also applies to Medicare, the public insurance program for the elderly. Medicare Advantage (MA) plans, like Medicaid HMOs, have an incentive to curb health care utilization although they benefit from risk adjusted premiums. Whether this occurs in practice, is an empirical question and an important avenue for further research.

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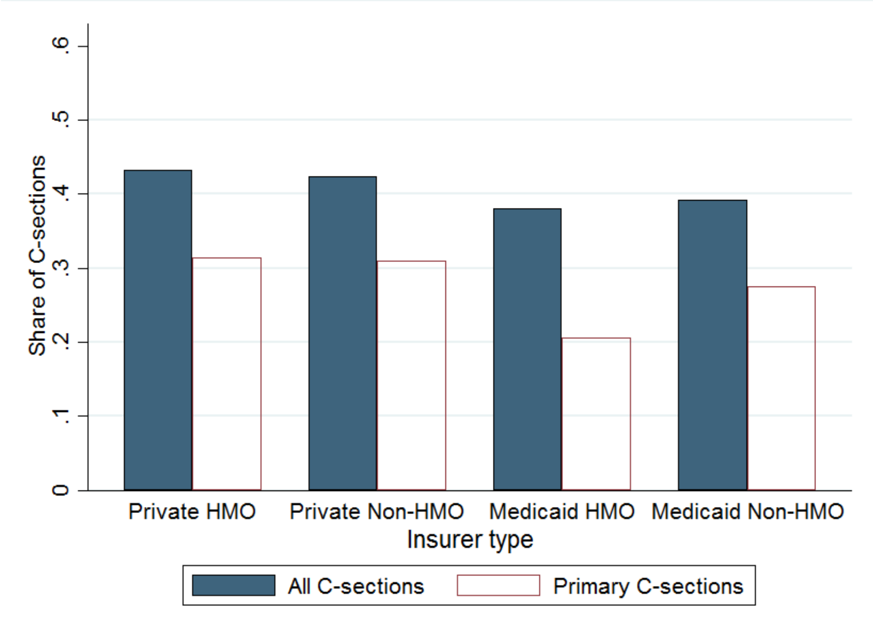
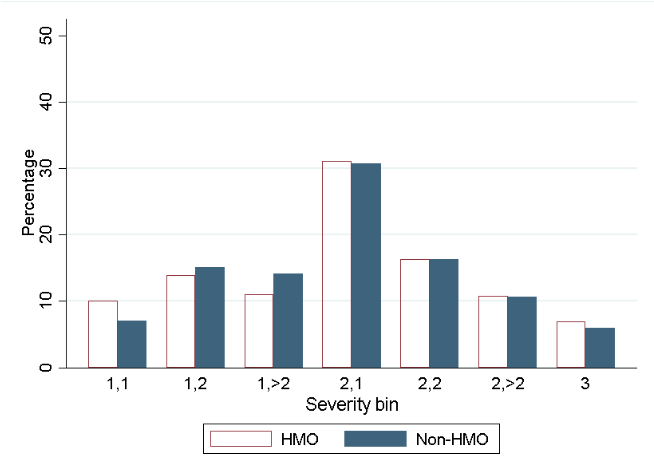
Figure 1: Insurers and C-sections



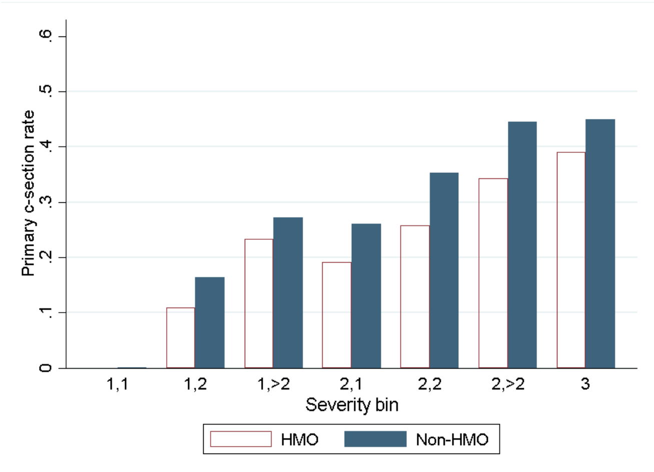
Notes: This figure presents the mean C-section rate for different patient groups in Florida in the year 2008. The four categories are privately insured HMO patients, privately insured Non-HMO patients, Medicaid funded HMO patients and Medicaid funded non-HMO patients. For each category the chart presents the mean C-section rate for all patients and only for those who have not had a prior delivery by C-section. Throughout the paper I refer to this as a primary C-section. Deliveries performed by nurses are excluded in order to focus on procedure choices by physicians. The mean C-section rate is higher for privately insured patients than for Medicaid patients. This is consistent with observations of previous studies. The overall C-section rate is similar for Medicaid HMO and non-HMO patients, but much lower for HMOs when we consider primary C-sections. Note that in private insurance the primary C-section rate is also similar for HMOs and non-HMOs. Financial incentives for private insurers do not change much whether the plan is HMO or not since they bear financial risk for the patient's health care spending in either case. However in Medicaid, non-HMOs do not bear any risk while HMOs do. This is a fundamental difference between the structure of Medicaid and Private insurance.

Figure 2: Co-morbidity severity and C-sections

(a) Distribution of patients



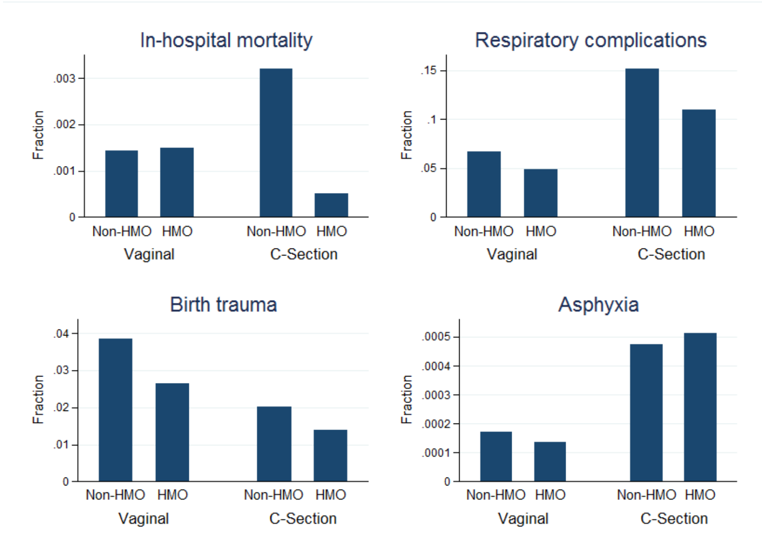
(b) Primary C-section rate



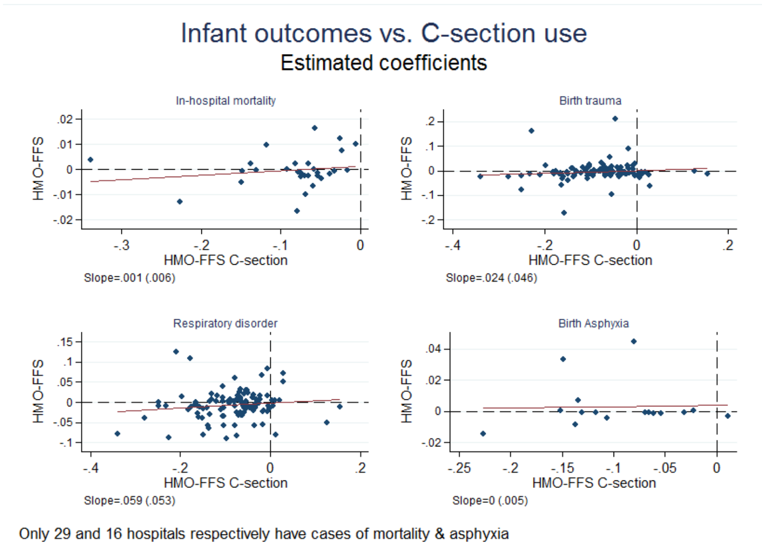
Notes: This figure presents evidence on co-morbidity severity of the obstetrics patients. Panel A compares the distribution of patients for HMO and non-HMO groups across different levels of co-morbidity severity. Severity ranks for co-morbidity conditions were defined in Ho and Pakes (2014). A rank of one denotes a routine condition (example, a headache). A rank of two indicates a moderately severe condition (example, uncomplicated Diabetes). A rank of three is assigned to severe conditions (example, hypertension with complications). A severity bin is defined by all patients who have the same severity rank for their most severe condition and the same number of conditions at this rank. Hence the bin "1,1" denotes all patients whose most severe condition has rank 1 and they have exactly 1 condition at this rank. The distributions are very similar with some minor differences. HMOs are less likely to have patients with maximum rank 1, although within this group their patients are more likely to be in the first bin. HMOs are also slightly more likely to have patients in higher severity bins. Panel B uses the same severity bins to compare the C-section rate between HMO and non-HMO patient groups. In general, the mean C-section rate increases as we move to a higher severity bin. In all bins, HMO patients have a lower mean C-section rate. In both panels, patients with prior deliveries by C-section are excluded.

Figure 3: Infant outcomes

(a) Frequency of adverse events

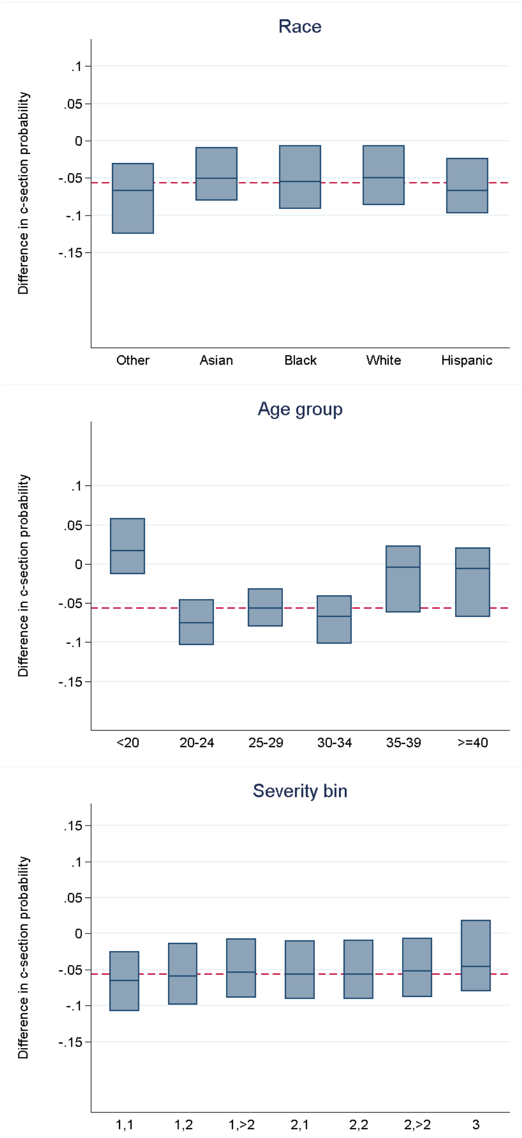


(b) Association with C-section rate



Notes: This figure presents evidence on the frequency of adverse outcomes for newborn infants covered by Medicaid. I consider four different outcomes - in-hospital mortality, respiratory complications, birth trauma and birth asphyxia. Panel A presents raw frequencies for all infants split by their insurance (HMO vs. Non-HMO) status and delivery (Vaginal vs. C-section) mode. Panel B links infant outcomes and use of C-sections by physicians for Medicaid patients. Since I cannot link infants and mothers directly, I study the association at the hospital level (113 hospitals). The Y-axis plots the risk-adjusted excess frequency of the adverse outcome for HMO infants. These values are estimated using β from linear probability regressions of the form $Y_i = \alpha + \beta 1(HMO) + \delta_j + \gamma_2 \boldsymbol{X}_i + \epsilon_i$ separately for each hospital. δ_j represents the fixed effect for the physician. The vector $\boldsymbol{X}$ includes indicators for maternal perinatal complications, congenital defects and pre-term delivery. The X-axis plots the risk adjusted excess primary C-section rate for HMO patients using the same specification as used for results presented in Table 2. I estimate α from equation (1) separately for each hospital. The red line depicts the slope coefficient estimated using weighted (by number of deliveries) least squares.

Figure 4: Counterfactual predicted C-section rates



Notes: This figure presents results from a counterfactual scenario if all non-capitated Medicaid patients were to be enrolled with HMOs. It uses results from the physician procedure choice model (column 3 of Table 4). Each panel plots the difference in C-section rate by patient group if they were to be HMO enrolled. So a positive value indicates that the primary C-section rate would be higher if the patient were to be HMO enrolled, and vice-versa. The box depicts the range of 25th-75th percentile of the distribution and the horizontal line indicates the median for the group. The dashed line indicates median for the whole sample. Panel A presents the counterfactual impact for patients of different racial groups. Intuitively, the impact is quite uniform across race. Panel B presents results by age group. The impact is largest for patients between ages of 20 and 35 and disappears for patients above 35. Panel C presents results by severity bin (explained in Fig 2). As the co-morbidity severity increases, the impact of HMO enrollment becomes weaker.

Table 1: Summary statistics

Panel A: Obstetrics cases			
Variable	Non-HMO	HMO	Total
Primary C-section	0.275	0.206	0.267
Scheduled	0.136	0.112	0.133
Max. severity=1	0.363	0.349	0.361
Max. severity=2	0.577	0.582	0.578
Max. severity=3	0.0598	0.0688	0.0608
Charlson=0	0.957	0.941	0.955
Charlson=1	0.0411	0.0559	0.0428
Charlson> 1	0.00193	0.00303	0.00206
Routine patient	0.734	0.712	0.731
White	0.420	0.292	0.405
Black	0.256	0.517	0.287
Hispanic	0.241	0.124	0.227
Other race	0.0824	0.0673	0.0806
Age< 20	0.179	0.273	0.190
Age 20-24	0.380	0.318	0.373
Age 25-29	0.241	0.249	0.242
Age 30-34	0.125	0.107	0.123
Age 35-50	0.0745	0.0533	0.0720
Observations	70,060	9,251	79,311

Panel B: Physicians			
	Non-HMO	HMO	Both
Number of physicians	596	45	904
Number of Medicaid cases	6,402	51	72,858
Mean # of Medicaid cases per physician	10.74	1.133	80.60
% HMO cases	0	1	0.149
% Non-HMO cases	1	0	0.851
Mean primary C-section rate	0.240	0.275	0.270
Mean primary C-section rate for non-HMO patients	0.240	-	0.279
Mean primary C-section rate for HMO patients	-	0.275	0.206

Notes: This table presents summary statistics from the principal data used for analysis in this paper. I removed cases with missing data, transfer cases from other hospitals and patients whose home county is outside Florida. I trimmed outlier cases with length of stay >30 or <1 - (less than 1% of the observations). I also excluded cases where the delivery was recorded as being performed by a nurse. To focus on primary C-sections, I exclude patients with prior deliveries by C-section (about 17,250). Panel A describes characteristics of the approx. 80,000 patients under study. White refers to non-Hispanic White and similarly Black refers to non-Hispanic Black. Other race includes Asian, Pacific islander and Native American. Scheduled C-sections were identified based on diagnoses listed in Gregory et al. (2002). Maximum severity refers to the highest severity rank of co-morbidity condition diagnosed for the patient. These ranks were defined in Ho and Pakes (2014) Appendix 4. 'Charlson' refers to the Charlson co-morbidity index defined by Charlson et al. (1987) to predict ten year mortality. Patients are tagged as 'routine' using a subset of conditions that Florida Medicaid uses to tag cases as 'High Risk'. Details are presented in Appendix Table A.1. Panel B presents the distribution of physicians into three groups - those that performed deliveries for Non-HMO only, HMO only and both types of Medicaid patients respectively.

Table 2: Delivery choice

Panel A: Medicaid patients					
Dependent variable:	**1**(C-sec.)				
	(1)	(2)	(3)	(4)	(5)
HMO enrollment	0.631***	0.648***	0.588***	0.587***	0.618***
	(-8.67)	(-14.12)	(-12.53)	(-12.31)	(-8.44)
Teaching Hosp.	0.855*				
	(-1.85)				
Invest. ownd. Hosp.	1.076				
	(1.17)				
Maternal distress	3.586***	3.423***	4.006***	4.039***	5.414***
	(15.49)	(15.96)	(15.15)	(15.21)	(17.00)
HMO*Mt. distress					2.065**
					(2.52)
Obesity		3.290***	3.072***	3.041***	3.110***
		(22.78)	(14.63)	(14.59)	(12.42)
HMO*Obesity					0.987
					(-0.06)
Cord prolapse		16.76***	20.51***	20.71***	35.30***
		(14.54)	(13.94)	(13.92)	(14.30)
HMO*Prolapse					0.712
					(-0.64)
Dystocia					25.49***
					(62.69)
HMO*Dystocia					0.740**
					(-2.52)
HMO*Age 35-50					1.072
					(0.37)
Fixed effects		Physician	Physician	Hospital × physician	Hospital × physician
Scheduled			Excluded	Excluded	Excluded
Health indicators				Yes	Yes
Observations	79,311	78,363	61,534	60,846	60,846
Panel B: Privately insured patients					
HMO enrollment	1.041	1.027	1.071**	1.065**	1.047
	(1.52)	(1.53)	(2.74)	(2.54)	(1.34)
Observations	86,368	85,790	65,480	64,713	64,713

Notes: This table presents the results obtained by estimating equation [1]. Panel A presents the results for Medicaid patients and Panel B for privately insured patients. The coefficient of interest is on HMO enrollment. It represents the odds of receiving a C-section for a HMO enrolled patient relative to a non-HMO patient. All columns exclude patients who have had prior deliveries by C-section. The baseline patient is White, non-HMO, aged 20-24 and delivered in a not-for-profit non-teaching hospital. Investor owned hospitals and teaching hospitals are mutually exclusive. All columns also include as controls indicators for race (Black, Hispanic, other), 5 year age bin ($<$ 20, 25-29, 30-34, $>$ 35) and Government ownership of the hospital. Standard errors computed for Column 1 are clustered by physician. Columns 2 & 3 use the main specification from Foo et al. (2013). Columns 3 onward exclude likely scheduled C-sections as well as cases with a history of hypertension or diabetes. Columns 4 onward include fixed effects for hospital-physician dyads. Column 4 also conditions on health indicators like the Charlson co-morbidity index and indicator of likely routine delivery (not reported). Column 5 includes interactions of HMO enrollment status with pregnancy complications. Standard errors are clustered by the panel variable. *t* statistics are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Robustness checks

Panel A: Conditions for which C-sections are medically necessary

A1: Mean C-section rate

Condition	Non-HMO N	Non-HMO C-sec rate	HMO N	HMO C-sec rate	p-value
1. Prior C-section	14,490	0.953	2,759	0.961	0.047
2. Placenta Previa	1,402	0.755	212	0.750	0.884
3. Herpes	2,582	0.507	429	0.506	0.977
4. Pre-eclampsia	3,790	0.610	518	0.587	0.312
5. Fetal malposition	6,504	0.824	754	0.826	0.875
6. Multiple gestation	1,024	0.801	152	0.836	0.313

A2: Delivery choice

Dependent variable: $\mathbf{1}$(C-sec.)	(1)	(2)	(3)	(4)	(5)	(6)
HMO enrollment	1.200	0.824	0.938	0.918	0.918	0.807
	(1.43)	(-0.72)	(-0.46)	(-0.70)	(-0.63)	(-0.56)
Observations	8,744	814	2,256	3,562	4,881	413

Panel B: Patient groups

	(1) Max. Sev.=1	(2) Max. Sev.=2	(3) Max. Sev.=3	(4) Age$<$ 25
HMO enrollment	0.609***	0.621***	0.700***	0.629***
	(-8.01)	(-12.01)	(-3.35)	(-8.63)
Observations	26,296	44,832	4,033	34,862

Notes: This table presents evidence related to Medicaid patients that have been diagnosed with specific delivery complications (Panel A) and other patient sub-sets (Panel B). Six complications have been identified by the National Health Service, UK (NHS) as necessitating C-sections, particularly when severe. Since prior C-section is one of the conditions listed, patients with prior deliveries by C-section are not excluded from analysis in Panel A. A1 presents the mean incidence of these conditions among HMO and non-HMO patients as well as results of a simple t-test of difference of means between the two groups. Non-specific conditions also listed by the NHS include small pelvis and heart condition. The NHS deems C-sections necessary after 2 or more prior C-sections, however since I cannot identify the number of prior C-sections, I present the results for all cases that have had a prior C-section. Note that active genital herpes makes C-sections medically necessary. The data does not identify whether the herpes was active or not. Panel A2 presents results from estimating equation [1] on the sub-set of patients that have been diagnosed with each of these six conditions. This is comparable to column 4 of Table 2. Note that the odds ratios are close to one across columns and none is statistically significant. The conditional logit estimation drops groups that don't have variation in the outcome, hence the number of observations used in the regressions is typically smaller than that in Panel A for the same condition. Panel B tests if the main results in Table 2 are being driven by compositional differences between HMO and non-HMO patient groups or by specific patient types. Columns 1,2 and 3 estimate within patient groups whose most severe co-morbidity is of the same rank. These severity ranks were defined in Ho and Pakes (2014) for about 200 co-morbidities associated with labor and delivery. For these three columns I don't exclude scheduled cases due to lack of observations among patients of maximum severity 3. Column 4 estimates on the sample of patients younger than 25. All specifications exclude patients with prior C-sections and estimate within hospital-physician dyads. t statistics are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered by hospital-physician dyad.

Table 4: Estimates of β_F

Dependent variable:	$\mathbf{1}$(C-section)		
	(1)	(2)	(3)
β_F	0.574***	0.822***	0.829**
	(10.43)	(8.95)	(8.77)
Physician-HMO			
% HMO deliveries	-0.0019	-0.042*	-0.042*
	(-0.30)	(-1.87)	(-1.76)
Physician-Hospital			
% hospital j deliveries	-0.00534*	0.013	0.0137
	(-2.04)	(1.10)	(1.08)
Hospital F.E.		Y	Y
Health interactions			Y

Notes: This table presents estimates of the weight that physicians put on patient related factors for non-HMO patients, β_F, normalized by the corresponding weight they use for HMO patients. These estimates are derived from a logit estimation of equation [4]. In all specifications, patients with prior deliveries by C-section and with scheduled C-sections or a history of hypertension or diabetes are excluded. The sample size for all specifications are the same as in column 3 of Table 2 (61,534). Column 1 estimates equation [4] without including hospital fixed effects in the physician private benefit equation. Column 2 introduces hospital fixed effects, hence utilizes only variation within hospitals. Column 3 also conditions on a vector of interactions of different pregnancy complications. All three columns also condition on features of the physician's practice - the proportion of her Medicaid deliveries that are funded by HMOs and the proportion performed at a specific hospital j. Standard errors are clustered by physician; *t* statistics are presented in parentheses. $^{*}\ p < 0.1$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$.

A Appendix: Additional figures and tables

Table A.1: Florida Medicaid definition of 'High risk' delivery

Variable	Mean	Std. Dev.	Ex-ante routine
Systematic malignancy	0	0	Y
Diabetes	0.054	0.226	Y
Hyperthyroidism	0.009	0.094	Y
Asthma	0.035	0.184	Y
AIDS	0.004	0.062	Y
Seizure disorder	0.004	0.064	Y
Haemoglobinopathies	0.012	0.11	Y
Severe anemia	0.079	0.27	Y
Cardiac disease	0.006	0.076	Y
Thromboembolic disease	0.000	0.021	Y
Eclampsia	0.046	0.021	
Hypertension	0.053	0.223	Y
Substance abuse	0.003	0.056	Y
Iso-immunization	0.001	0.025	
Suspected fetus abnormality	0.017	0.129	
Placenta previa	0.017	0.128	
Premature rupture	0.113	0.316	
Multiple gestation	0.012	0.11	Y
Psychiatric disorder	0.037	0.188	Y
Herpes	0.031	0.174	Y
Abnormal presentation	0.007	0.083	
Chorioamnionitis	0.018	0.135	
Grand multiparity	0.007	0.086	
Tuberculosis	0.000	0.007	Y
Chronic liver disease	0.002	0.042	Y
Chronic kidney disease	0.002	0.042	Y
Carcinoma cervix	0.000	.0018	Y
Observations	79,311		

Notes: This table presents summary statistics related to co-morbidity conditions that Florida's Medicaid program lists as being associated with a 'High Risk' delivery. If any of these conditions is diagnosed, the delivery is automatically treated as high risk and reimbursed at a higher rate (irrespective of delivery procedure). Each of these conditions and corresponding ICD-9 diagnosis codes were specified by the Florida Medicaid program (AHCA, 2012). Observe that complications like Fetal distress and Dystocia are not considered high risk factors by the program. Column 4 indicates which of these conditions is used to construct the indicator for a 'routine delivery'. The purpose of this indicator is to simulate the type of information observable to a HMO that recruits a prospective enrollee well before her due date. Hence conditions like Eclampsia, Placenta Previa and others that usually present at the time of delivery or in the last trimester are not considered while constructing this indicator.

Table A.2: Summary statistics: Infants

	Non-HMO	HMO	Total
C-section	0.364	0.348	0.363
White	0.402	0.312	0.392
Black	0.264	0.506	0.290
Hispanic	0.248	0.114	0.234
Other race	0.0861	0.0684	0.0842
Died	0.00209	0.00117	0.00199
Respiratory compl.	0.0934	0.0668	0.0905
Birth trauma	0.0318	0.0221	0.0308
Asphyxia	0.000283	0.000269	0.000282
Congenital defect	0.120	0.103	0.118
Maternal complication	0.0377	0.0284	0.0367
Gestation<37 weeks	0.0825	0.0604	0.0801
Low birth weight	0.0673	0.0505	0.0655
Observations	91,788	11,142	102,930

Notes: This table presents summary statistics related to newborn infants for the year 2008 and covered by Medicaid. The data does not allow me to link newborns with mothers directly. Newborns are identified using the appropriate DRG codes. Infants delivered via C-section are identified using primary diagnosis codes. Since infants and mothers cannot be linked, it was not possible to determine cases where the mother had a prior C-section. Hence this represents all deliveries covered by Medicaid. White refers to non-Hispanic White and similarly Black refers to non-Hispanic Black. Other race includes Asian, Pacific islander and Native American. In-hospital mortality is determined using the discharge status. The other complications/outcomes are identified using the following ICD-9 diagnoses codes: Birth trauma (767.x), Asphyxia (768.5,768.6,768.9), Respiratory complications (769.x,770.x), Congenital defects(740-759.9), Maternal complications (760-763) and pre-term delivery(765.21-765.28).

Table A.3: Summary statistics: Private patients

	Non-HMO	HMO	Total
Primary C-section	0.290	0.314	0.299
Scheduled	0.150	0.157	0.153
Max. severity=1	0.390	0.401	0.394
Max. severity=2	0.556	0.551	0.554
Max. severity=3	0.0532	0.0486	0.0514
Charlson=0	0.967	0.967	0.967
Charlson=1	0.0307	0.0314	0.0310
Charlson>1	0.00180	0.00138	0.00163
Routine patient	0.747	0.749	0.748
White	0.579	0.572	0.576
Black	0.143	0.163	0.151
Hispanic	0.186	0.158	0.175
Other race	0.0925	0.106	0.0980
Age<20	0.0635	0.0461	0.0566
Age 20-24	0.185	0.146	0.169
Age 25-29	0.304	0.305	0.304
Age 30-34	0.271	0.306	0.285
Age 35-50	0.177	0.198	0.185
Diabetes	0.0608	0.0640	0.0621
Hypertension	0.0536	0.0557	0.0544
Observations	52,335	34,033	86,368

Notes: This is a companion table to Table 1 Panel A and provides information on privately insured maternity patients. These summary statistics relate to the results presented in Table 2 Panel B. This sample was constructed using identical sample restrictions as for the Medicaid patients. To focus on primary C-sections, I exclude patients with prior deliveries by C-section (about 18,500). White refers to non-Hispanic White and similarly Black refers to non-Hispanic Black. Other race includes Asian, Pacific islander and Native American. Scheduled C-sections were identified based on diagnoses listed in Gregory et al. (2002). Maximum severity refers to the highest severity rank of co-morbidity condition diagnosed for the patient. These ranks were defined in Ho and Pakes (2014) Appendix 4. 'Charlson' refers to the Charlson co-morbidity index defined by Charlson et al. (1987) to predict ten year mortality. Patients are tagged as 'routine' using a subset of conditions that Florida Medicaid uses to tag cases as 'High Risk'. Details are presented in Appendix Table A.1.

B Obstetrician access and practice characteristics

In the main analysis I abstracted away from the issue of provider networks and access. The main specification conditions on the provider (hospital-physician) dyad when it estimates the impact of HMO enrollment. However, the policy debate over the deployment of HMOs in Medicaid is equally concerned with the issue of provider access. Are HMO patients able to access a very limited network of physicians relative to non-HMO patients? Are the physicians that accept HMO or both types of patients different than those that accept only non-HMO patients? More generally, physician access for Medicaid patients is an issue of great concern. Hospital discharge data is not designed to directly answer these questions since one cannot observe the provider network available to the patient. However, it is still useful to document the patterns we observe from hospital records.

This section documents differences in obstetricians in Florida, based on whether they treat Medicaid or privately insured patients, and within these broad categories, whether they treat HMO or non-HMO patients. I categorize patients into four insurer-based bins - Private HMO, Private non-HMO, Medicaid HMO and Medicaid non-HMO.

Figure B.1 shows the proportion of physicians that have performed deliveries for patients covered by different types of insurer sets. Note that this quantity is not the same as access. But it helps set a lower bound on access. For example, the figure shows that about 15% of physicians treated only privately insured patients, implying that 85% of physicians treated at least 1 Medicaid patient. Note that about 15% physicians did not treat any private patient - so not all physicians treat private patients. In fact this figure indicates that access for private and Medicaid patients is similar. 70% of the physicians treat both Medicaid and privately insured patients, showing that a large proportion of physicians is accessible to both types of patients. About 50% of the physicians performed deliveries for at least one Medicaid HMO patient. Of the physicians that treated at least 1 Medicaid patient, about 65% treated an HMO patient. This indicates that among physicians that accept Medicaid beneficiaries, HMO patients have access to at least two-thirds of the physicians. So HMO patients may have limited access, even within Medicaid patients.

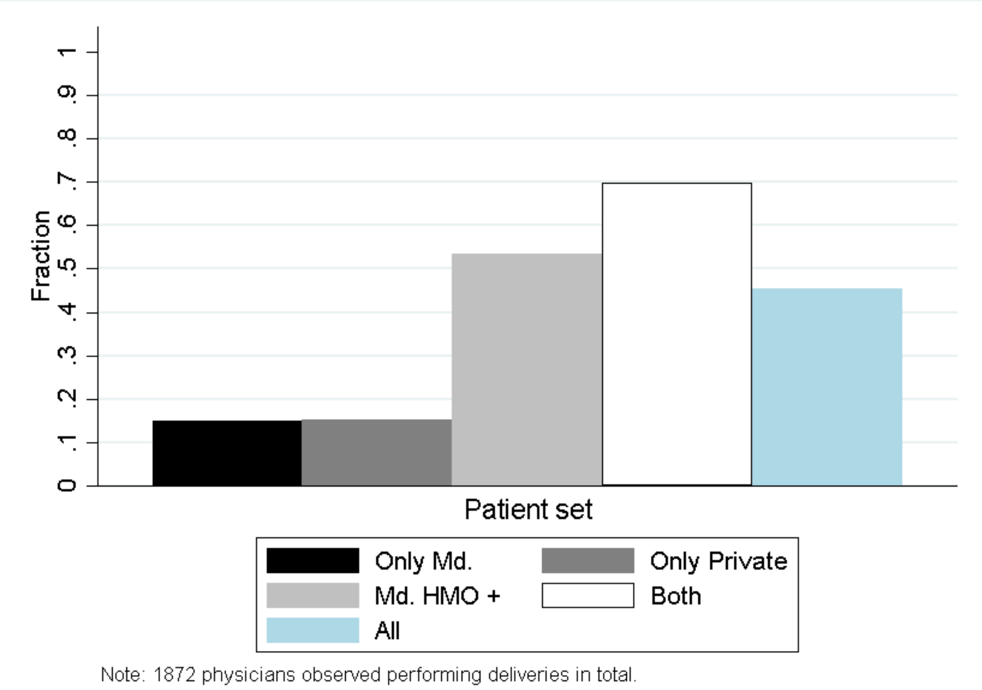
Next I check if the structure of practice is different for obstetricians that deliver for Medicaid patients vs. those that deliver for privately insured patients. Within this broad classification I further split by HMO vs. non-HMO. Fig B.2 presents the mean share of patients belonging to each of the four insurer bins, separately for physicians that treat Medicaid (Panel A) and privately insured (Panel B) patients. Within each panel I compare the mean share of practice by insurer type across all physicians that treat HMO vs. non-HMO patients. If a physician has treated both HMO & Non-HMO patients, then she will appear in both charts within a panel. However her weight in the two charts will vary depending on how many deliveries of each type she has performed. Similarly, if a physician has performed deliveries for both Medicaid and Privately insured patients, she will appear in both panels. Panel A suggests that the shares are quite similar for HMO and non-HMO physicians across all 4 bins. For both groups, Medicaid non-HMO patients account for about 60% of their practice. Both types see few privately insured patients, about 30%. Hence physicians treating Medicaid patients tend to see few privately insured patients.

Panel B of figure B.2 repeats the analysis, but for obstetricians that deliver for privately insured patients. Here the split is more even, with a much lower share of Medicaid patients. Collectively Medicaid patients contribute about 25-30% of the patient share. Within privately insured patients, the difference between physicians that treat HMO and non-HMO patients seems to be greater than it is for physicians that treat Medicaid patients (Panel A). Hence HMO/non-HMO insurer type seems to be a more material distinction for privately insured patients relative to Medicaid patients. Figures B.1 and B.2 together tell us that while obstetrician access is not an issue for Medicaid patients (even Medicaid HMO patients), Medicaid and privately insured patients are very unlikely to see the same physician. Physicians that treat privately insured patients tend to see few Medicaid patients and vice-versa. Some of this could be driven by location sorting. This pattern could have implications on quality of care, but these issues are outside the scope of this analysis.

I then focus on physicians that treat Medicaid patients and study certain attributes of her practice, depending on whether she treats HMO or Non-HMO patients. Figure B.3 shows the cumulative distribution of primary C-section rates and number of deliveries performed for physicians, separately for those that treat HMO and non-HMO patients. Panel A shows that the median physician, whether she treats HMO or Non-HMO patients, has a primary

C-section rate of approximately 25% (Non-HMO physicians have a slightly higher C-section rate). Similarly, the median size of practice is approximately 200 deliveries (per year) regardless of whether the physician treats HMO or Non-HMO patients. Collectively, figures B.2 and B.3 indicate that physicians treating the two types of Medicaid patients are quite similar in their size of practice, primary C-section rate and patient shares by insurer type.

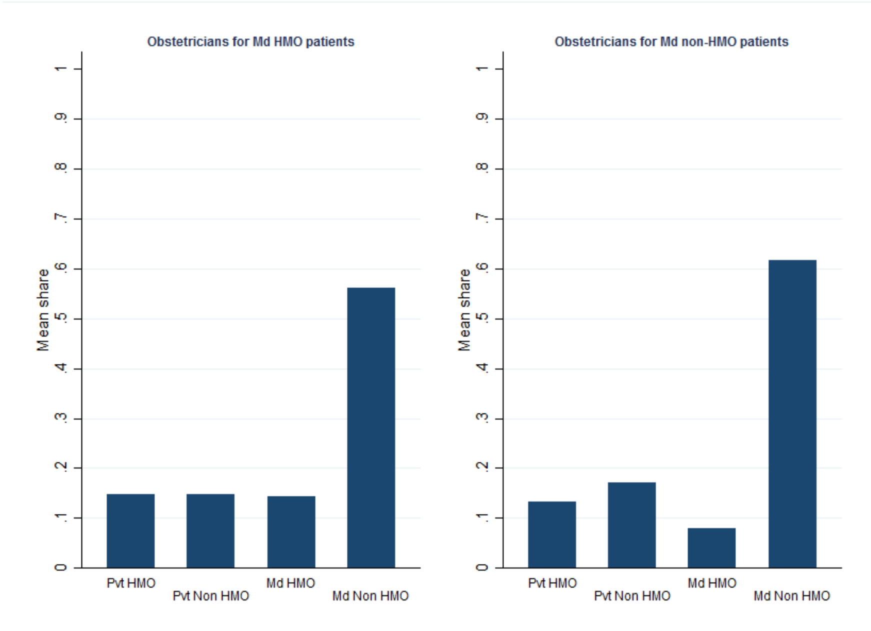
Figure B.1: Physician access



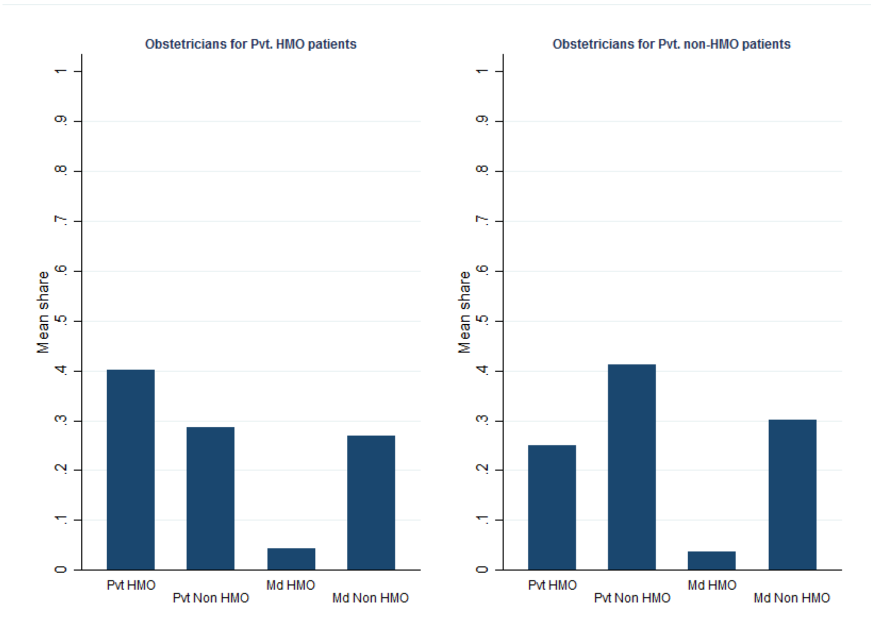
Notes: This figure shows the proportion of obstetricians in Florida that have performed deliveries for patients from different types of insurer sets. This quantity serves to define the lower bound on access, but is not the same as access. The different categories considered are - only Medicaid (or no privately insured), only privately insured, at least one Medicaid HMO patient, both Medicaid and privately insured and all types of patients (Medicaid HMO, non-HMO and privately insured HMO, non-HMO). These categories are not mutually exclusive. I observe a total of 1,872 physicians in the data.

Figure B.2: Share of practice

(a) Obsetricians serving Medicaid patients



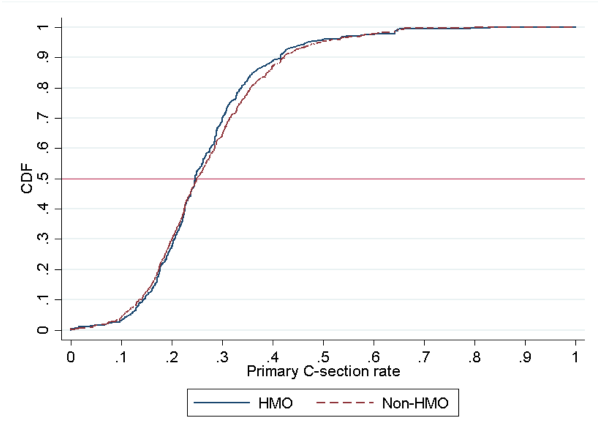
(b) Obsetricians serving Privately insured patients



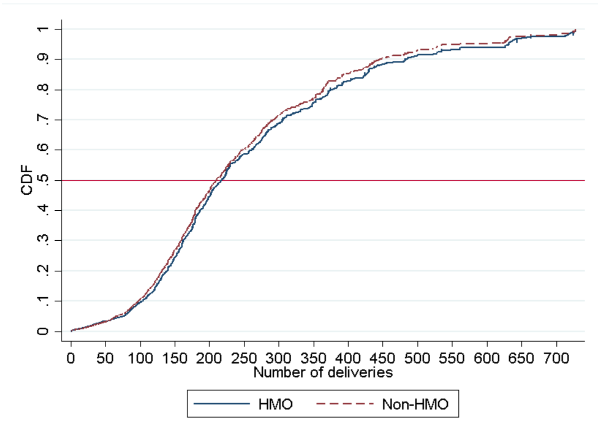
Notes: This figure compares the share of insurers based on number of patients for obstetricians serving patients covered by different insurers. Physicians serving Medicaid patients are represented in Panel A and those serving Privately insured patients are represented in Panel B. Note that there are overlaps across panels, i.e. if a physician delivers babies for both types of patients, then she is included in both panels. Each panel contains two charts. The chart on the left presents the mean share of practice by insurer type across all obstetricians serving the HMO subset of patients. Correspondingly, the chart on the right presents the mean split for all obstetricians serving the non-HMO subset of patients. Again, within a panel, there are overlaps across both charts - i.e. the same physician will be represented in both charts if she delivers babies for both HMO and non-HMO patients.

Figure B.3: Practice characteristics

(a) Primary C-section rate



(b) Size of practice



Notes: This figure compares physicians that treat Medicaid HMO and non-HMO patients on two attributes. Panel A shows the cumulative distribution of primary C-section rates. Panel B shows the cumulative distribution of number of deliveries performed, as a proxy for the size of her practice. Note this includes all deliveries for both Medicaid and privately insured patients. The solid blue line represents physicians that treat HMO patients, while the dashed red line represents physicians that treat non-HMO patients. In both cases, the median physician is quite similar regardless of whether she treats HMO or non-HMO patients. This is not surprising given that 60% of physicians treat both types of patients and hence appear in both distributions. For such physicians, the weight in the two distributions is proportional to the corresponding number of patients she treats of each type.