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Drivers of Racial Differences in C-Sections

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Abstract

Black mothers with unscheduled deliveries are 25 percent more likely to deliver by C-section than non-Hispanic white mothers. The gap is highest for mothers with the lowest risk and is reduced by only four percentage points when controlling for observed medical risk factors, sociodemographic characteristics, hospital, and doctor or medical practice group. Remarkably, the gap disappears when the costs of ordering an unscheduled C-section are higher due to the unscheduled delivery occurring at the same time as a scheduled C-section. This finding is consistent with provider discretion—rather than differences in unobserved medical risk—accounting for persistent racial disparities in delivery method. The additional C-sections that take place for low-risk women when hospitals are unconstrained negatively impact maternal and infant health.

I Introduction

Persistent and well-documented differences in the medical care received by Black and white Americans raise questions about the sources of racial disparities in treatment (IOM, 2003; Caraballo et al., 2022). Gaps in income, wealth, education, insurance coverage, and other markers of socioeconomic status could affect access to health care and the providers that people of different races see (Himmelstein and Himmelstein, 2020; Office of Minority Health, 2022). These underlying socioeconomic factors, coupled with disparities in access to care, could also lead to racial differences in medical risk factors at the point of treatment.[1] Furthermore, it is plausible that Black individuals have different preferences for medical care on average, potentially influenced by historical experiences of discrimination within the health care system (Darity and Turner, 1972; Washington, 2006; Alsan and Wanamaker, 2018). Additionally, disparities in care provision could arise from biases held by medical practitioners, whether explicit or implicit (Salm Ward et al., 2013; Hall et al., 2015; Hoffman et al., 2016).

This paper addresses the question of why Black infants are more likely to be delivered by Cesarean section (C-section) than white infants in the United States. In 2018, 29.3 percent of non-Hispanic white mothers delivered by C-section compared to 34.0 percent of Black mothers (NVSS, 2018).[2] While Cesarean deliveries can be lifesaving, unnecessary C-sections increase the costs of medical care and involve a higher risk of maternal complications than vaginal births (Sandall et al., 2018). Higher rates of C-sections among Black mothers could thus be one contributor to higher rates of Black maternal morbidity (Kennedy-Moulton et al., 2022). Cesarean deliveries can also complicate future pregnancies, and, once a C-section has been performed, subsequent births are likely to require a C-section (Silver, 2012). Notably, the children themselves can also be affected, with recent evidence showing that children delivered by C-section are more likely to suffer from respiratory conditions in infancy and

[1] Black Americans have higher rates of diabetes, hypertension, obesity, asthma, and heart disease compared to white Americans (CDC, 2023).

[2] The higher use of C-sections among Black mothers contrasts with racial disparities in other types of care provision during and following labor. Studies have shown that Black mothers are less likely to undergo labor induction (Grobman et al., 2015), are less likely to be given epidural anesthesia while in labor (Glance et al., 2007), and are less likely to be given opioids despite reporting higher pain following delivery (Badreldin et al., 2019). These differences could be driven by differences in preferences—with Black mothers preferring less invasive treatments—or providers showing less concern for the comfort of Black mothers.

childhood (Costa-Ramon et al., 2018, 2022; Card et al., 2023).

We use exceptionally rich administrative data covering nearly one million births in New Jersey from 2008 to 2017 to understand the causes of racial disparities in delivery method. We focus much of our analysis on unscheduled deliveries, as C-sections after a trial of labor are arguably less likely to reflect maternal demand for C-sections than scheduled deliveries.[3] We use a random forest algorithm to predict C-section risk based on maternal health factors and control for sociodemographic variables to compare delivery methods among mothers of different races but with the same health insurance, education level, and marital status. We further condition on hospital of delivery and even attending physician to examine differences in the way that patients are treated both within hospitals and by the same doctor. Finally, we use information on hospital and time of delivery for scheduled C-sections to generate variation in the costs of ordering an unscheduled C-section. As outlined below, this variation is used to investigate whether the persistent racial gap among observably similar mothers delivering in the same hospital is driven by differences in unobserved health risk or provider discretion. We further use this variation and linked hospital discharge data to examine how marginal C-sections affect postpartum maternal and fetal health.

Over our sample period, Black mothers in New Jersey with an unscheduled delivery were on average 24.8 percent (p-value = 0.005) more likely to have an unscheduled C-section than non-Hispanic white mothers.[4] This disparity is most pronounced for mothers in the lowest risk quintile (149.4 percent, p-value < 0.001), although a slight gap exists even among mothers in the highest risk quintile (12.3 percent, p-value = 0.046). These differences persist conditional on measures of socioeconomic status such as Medicaid coverage and education level, highlighting that pronounced differences in C-section rates are present among women with similar observable characteristics. Strikingly, controlling for the hospital of delivery and

[3] If someone desires to deliver by C-section, they can find a doctor willing to schedule such a delivery. The American College of Obstetricians and Gynecologists (ACOG) outlines that a "Cesarean delivery on maternal request" may be performed after 39 weeks if the risks and benefits have been discussed with the patient (ACOG, 2019). StatPearls, an online resource for health care professionals, lists "Maternal request" as second on a list of maternal indications for a Cesarean, preceded only by "Prior Cesarean delivery" (Sung and Mahdy, 2023).

[4] Unscheduled C-section rates are calculated as the number of unscheduled C-sections divided by the total number of unscheduled births. From 2008–2017, the unscheduled C-section rate among Black mothers in New Jersey was 21.1 percent compared to 16.9 percent among non-Hispanic white mothers (see Table 1).

the attending physician leaves much of the baseline disparity intact: even after controlling for medical risk, measures of socioeconomic status, hospital fixed effects, and doctor fixed effects, Black mothers remain 20.1 percent (p-value < 0.001) more likely to receive an unscheduled C-section than their white counterparts. These findings show that even the same doctors are treating Black patients differently.

Previous research has suggested that one potential solution for racial gaps in treatment is to encourage racial concordance between providers and patients (Alsan et al., 2019; Gruber and Frakes, 2022; Hill et al., 2023; Ye and Yi, 2023). We examine the effect of racial and gender concordance between patients and providers using hand-collected data on the race and gender of physicians inferred from pictures on provider websites. We find only suggestive evidence that racial concordance reduces the racial gap in unscheduled C-section rates: although the racial gap in unscheduled C-sections among Black doctors is smaller than the racial gap among white doctors (14.9 percent versus 22.3 percent), the difference is not statistically significant (p-value $= 0.237$). We similarly find no evidence of significant differences between male and female doctors, with physicians of both genders treating Black and white mothers differently.

An important question is whether the persistent racial gap in unscheduled C-section rates among observably similar women in the same hospital is due to unmeasured risk factors affecting Black mothers. To address this concern, we exploit plausibly exogenous variation in the costs to providers of ordering an unscheduled C-section generated by variation in the timing of scheduled C-sections. Given limited surgical resources within a labor and delivery unit, unscheduled C-sections are significantly less likely when the delivery occurs at the same time as a scheduled C-section. If the gap in unscheduled C-section rates is driven by differences in unobserved risk factors—with Black mothers being unobservably more in need of unscheduled C-sections than their white counterparts—then doctors should reduce unscheduled C-sections among white mothers with similar observable risk when the costs of C-sections increase, thereby increasing the racial gap. Instead, if the gap in unscheduled C-section rates is driven by additional unnecessary C-sections being performed on Black mothers, then doctors should reduce such C-sections first when faced with increased costs, thereby leading the racial gap to decline.[5]

We find that the racial gap in unscheduled C-sections falls in the presence of increased costs due to reduced capacity. When there is no scheduled C-section at the time of an unscheduled delivery, 4.8 percent of non-Hispanic white mothers with unscheduled births in the lowest risk quintile have a C-section compared to 8.0 percent of Black mothers, leading to a racial gap of 67.9 percent (p-value < 0.001). When there is a scheduled C-section, the white rate for the lowest risk births falls to 1.6 percent and the Black rate falls to effectively zero, reducing the gap to an insignificant -69.9 percent (p-value $= 0.412$). Among high-risk mothers with unscheduled births, delivering when there is a scheduled C-section reduces the probability of having a C-section from 55.3 percent to 38.9 percent, with no significant difference in the effects on Black and white mothers (p-value $= 0.889$). These findings are inconsistent with the argument that the racial gap in unscheduled C-sections is driven by unobserved risk factors affecting Black mothers. Instead, these findings suggest that the racial gap is driven by a higher propensity of doctors to perform C-sections on low-risk Black patients when the costs of doing so are low.

Changes in unscheduled C-section rates due to temporary fluctuations in hospital capacity for such deliveries have associated health effects. We follow mothers and children in the hospital discharge data, which allows us to measure complications that occur outside of the immediate postpartum period and results in a more accurate measure of complications than is usually available.[6] Among low-risk mothers of both races, reductions in unscheduled C-sections when the delivery occurs at the same time as a scheduled C-section reduce infant admissions to the neonatal intensive care unit (NICU). Reductions in unscheduled C-sections also reduce overall postpartum complications among low-risk white mothers and reduce complications involving the C-section wound among low-risk Black mothers. Among high-risk mothers, reductions in unscheduled C-sections resulting from the same constraints have little impact on maternal complications or Black infant health but increase NICU admissions

[5] The gap might also fall if Black mothers are more likely to demand a C-section after a trial of labor, and doctors are less likely to accommodate such requests when the costs of doing so are higher. However, existing evidence suggests that Black mothers are, if anything, less likely to request C-sections than white mothers (Trahan et al., 2022).

[6] Birth certificate data have been shown to substantially under-estimate maternal postpartum morbidities and to have poor validity because many complications occur after the initial hospital stay for the delivery (Gemmill et al., 2024).

among white infants. Taken together, the results indicate that the additional C-sections done on low-risk mothers when the costs are low lead to worse maternal and infant health. The findings further suggest that unscheduled C-sections are better targeted among high-risk white mothers than high-risk Black mothers when capacity is not limited.

Our work is most closely related to two literatures. The first is a large body of work aiming to uncover the drivers of high C-section rates. C-sections in the United States have risen dramatically over time—from 20.7 percent of births in 1996 to 32.1 percent in 2021—and are now the most common major surgery in the country (NVSS, 2022). The high rate of C-sections has raised alarm among policymakers and professional organizations (WHO, 2015; ACOG, 2014; ODPHP, n.d.) and has led to a number of studies aimed at identifying contributing factors and potential solutions.[7] Racial disparities in C-section rates are also persistent and well documented (e.g., Braveman et al. 1995; Fishel Bartal et al. 2022). We build on this work by examining the forces leading to different rates of C-sections among Black and non-Hispanic white mothers and show that one of the prime candidates for explaining high C-section use—provider discretion—can likely also help explain racial differences in delivery method.

Our work further relates to the literature aimed at documenting and understanding the forces underlying racial disparities in access to and use of health care services in the United States. Black Americans have worse health on average, as evidenced by higher rates of chronic disease and lower life expectancy than non-Hispanic white Americans (National Academies, 2017; CDC, 2023). While these health disparities are driven by many forces, including pronounced differences in many social determinants of health (Town et al., 2024), of particular concern for the medical community are racial differences in the health care received by patients (IOM, 2003). We add to work showing that racial disparities in treatment are driven by differences in the providers that patients see (Jha et al., 2011; Chandra et al., forthcoming), the health insurance that patients hold (Yearby, 2011), and bias among practitioners (Stepanikova, 2012; Centola et al., 2021; Singh and Venkataramani, 2022), by

[7]For example, work has considered the role of financial incentives and physician induced demand (Gruber and Owings, 1996; Gruber et al., 1999; Johnson and Rehavi, 2016), patient appropriateness for C-sections (Robinson et al., forthcoming), and the legal environment (Currie and MacLeod, 2008) in explaining levels and trends in C-section use. We review the large literature on determinants of C-section use and discuss implications for racial disparities in delivery method in Section II.

showing that provider discretion likely plays a role in explaining racial differences in the burden of unnecessary C-sections. These results suggest that policies aimed at reducing C-sections and racial disparities in birth outcomes could usefully target unnecessary C-sections among low-risk Black women.

The rest of the paper proceeds as follows. Section II provides a background about factors contributing to the use of C-sections. The data sources used in our study are described in Section III, and Section IV provides new evidence on the racial gap in C-section rates. Section V investigates the drivers of the disparity, while Section VI considers the health consequences. A discussion and conclusions are provided in Section VII.

II Background

In this section, we outline the reasons that C-section rates could differ by race, review the related literature, and outline how the detailed nature of our data will allow us to build on existing work. The channels considered include factors stemming from differences across mothers—including medical risk factors, preferences, insurance coverage, and health literacy—and factors stemming from differences across and within providers—including average propensity to perform a C-section and bias.

Differences across mothers Medical risk factors for C-section include conditions such as breech presentation (Yang and Mullen, 2020), obesity (Glazer et al., 2020), and older maternal age (Penfield et al., 2017). Hence, it is important to control for such risk factors in a flexible way when evaluating the causes of racial disparities, though Robinson et al. (forthcoming) show that Black C-section rates are less sensitive to underlying medical risks, suggesting that other mechanisms besides differences in reported risk factors must be at work. Moreover, as we will show in Section III below, Black mothers in New Jersey have lower risk of needing a C-section than white mothers in terms of their observable medical risk factors. Although Black mothers have higher rates of obesity, herpes, and a few other indications for a C-section, Black mothers are significantly younger on average, and age is an important predictor of having a C-section.

Racial disparities in C-section rates could also reflect differences in patient tastes. McCourt et al. (2007) summarize the existing literature on the subject and conclude that despite persistent claims that consumer demand is a significant driver of C-sections, very few women actually request them in the absence of medical risk factors.[8] The American College of Obstetricians and Gynecologists (ACOG) estimates that about 2.5 percent of U.S. births are C-sections due to maternal request (ACOG, 2019), suggesting that the vast majority of C-sections are performed for other reasons. These findings are in line with Dranove et al. (2011), who find that expecting parents tend to avoid practitioners who have higher than expected C-section rates. In what follows, we focus primarily on unscheduled C-sections to isolate the population for whom C-section was not their *a priori* preferred delivery method.

Differences in insurance coverage might also contribute to racial differences in delivery method. Many studies have documented higher C-section rates among mothers covered by private insurance relative to public insurance, differences that are typically attributed to higher provider reimbursement rates among the privately insured (Hoxha et al., 2017). However, financial incentives for performing C-sections are still present under public insurance, and C-section rates among Medicaid beneficiaries rise when the fee differential between C-sections and vaginal deliveries increases (Gruber et al., 1999). It is thus important to control for insurance type when examining disparities in delivery method, as we do below.

Maternal characteristics such as health literacy have also been shown to be important determinants of C-sections (Yee et al., 2021). Using detailed data from California, Johnson and Rehavi (2016) show that higher fees for C-sections compared to natural deliveries are associated with higher C-section rates, except when the mother is a physician. One interpretation of this finding is that the superior health knowledge and/or self-advocacy of mothers who are physicians defends them against the imposition of unnecessary C-sections. If health knowledge and self-advocacy vary with race, then these factors could contribute to racial disparities in health care (Wiltshire et al., 2006). Although we cannot directly control for health literacy and self-advocacy, we will show that the racial gap in C-sections holds conditioning on maternal education, a strong correlate of these factors (WHO, 2013).

[8] Weaver and Magill-Cuerden (2013) analyze the rise of the phrase “too posh to push,” and conclude that “press handling of the topic has continued to contribute to the impression that Cesarean purely for maternal request is common.”

Differences across and within providers A large literature documents variation in the propensity to perform C-sections on people with similar observable medical risk factors across hospitals (Card et al., 2023), medical practices (Chauhan et al., 2008), and individual doctors (Epstein and Nicholson, 2009; Dranove et al., 2011; Currie and MacLeod, 2017). To the extent that Black people use different hospitals, practices, or providers, then this might explain some of the observed differences in C-section rates. Jha et al. (2011) and Chandra et al. (forthcoming) find that Black people tend to use hospitals of lower quality, which might be correlated both with higher rates of unnecessary C-sections as well as with failures to perform necessary C-sections. Among individual physicians, some of the variation in the propensity to preform a C-section can be attributed to differences in physician fees (Gruber and Owings, 1996; Gruber et al., 1999), legal environments (Currie and MacLeod, 2008), diagnostic and surgical skills (Currie and MacLeod, 2017), and the provider's recent experience with the surgery (Singh, 2021). These findings underscore the key role of providers in choosing the mode of delivery and motivate the inclusion of hospital and medical group or physician fixed effects in Section V.A below.

Implicit and explicit forms of bias on the part of individual practitioners may also be important in driving differential C-section rates (Williams et al., 2019). Using health records from two hospitals, Singh and Venkataramani (2022) show that the racial gap in in-hospital mortality grows when hospitals are capacity constrained, suggesting that practitioners are more likely to direct scarce time and resources to white patients.[9] In the context of childbirth, Black patients are more likely to report that they felt pressure from a clinician to take medication to start or speed up labor and to have a C-section (Logan et al., 2022). Race may also be "baked into" medical practice, such as through the use of algorithms that predict a lower risk of success in vaginal birth after Cesarean in Black patients with identical risk factors to those of white patients (Vyas et al., 2020).[10] As outlined in Section V.A below, we use variation in the costs of ordering an unscheduled C-section generated by variation in whether the unscheduled delivery occurs at the same time as a scheduled C-section to ask

[9]These findings are in line with work by Stepanikova (2012) showing that time pressure can exacerbate racial bias in clinical decision making.

[10]The inclusion of race in clinical prediction models is widely debated (Briggs, 2022; Manski, 2022), although research suggests that not using all information available to a clinician, including patient race, may lead to worse expected health outcomes for patients (Manski et al., 2023).

whether higher C-section rates among Black mothers might be driven by doctors having a higher propensity to perform unnecessary C-sections on Black mothers.

One potential solution to provider bias is to prioritize racial (or gender) concordance between doctors and patients. In an influential experiment, Alsan et al. (2019) found that Black men were more likely to accept recommended preventive care from Black providers. Recent work by Gruber and Frakes (2022), Hill et al. (2023), and Ye and Yi (2023) shows that racial concordance between doctors and patients leads to improved care and better patient outcomes. Greenwood et al. (2020) provide descriptive evidence suggesting that Black physicians significantly reduce Black infant mortality. Focusing on gender concordance, Cabral and Dillender (2024) find that female doctors are more likely than male doctors to approve workers' compensation claims for female patients. Survey data also suggests that racial, ethnic, and gender concordance is associated with higher participation in cancer screenings and other preventive health services (LaVeist et al., 2003; Malhotra et al., 2017). We investigate the importance of race and gender concordance in our setting below.

In summary, the past literature points to many possible sources of racial gaps in C-section rates. Racial disparities could reflect racial differences in the prevalence of risk factors, insurance coverage, or in the hospitals or providers used—the analysis that follows will control for these factors. It seems less likely that racial gaps primarily reflect differences in demand, but we will aim to limit the importance of this channel by focusing most of our attention on unscheduled C-sections. The results indicate that the same providers treat Black and white mothers who are otherwise observably similar differently, and we will consider several possible explanations.

III Data

The primary data for this study come from 993,165 New Jersey Electronic Birth Certificate (EBC) records for 2008 to 2017. The EBC records include rich information on delivery method, maternal medical risk factors, hospital of delivery (68 unique hospitals), and attendant provider's name (1,704 unique providers). The data further include self-identified patient race and other sociodemographic characteristics including education, age, marital status, zip code of residence, and participation in Medicaid.[11]

To evaluate the role of the doctor's practice and of racial and gender concordance, we supplement the birth records with novel data on the attending physician's current practice group, race, and sex. This information was compiled by googling each physician's name to find the provider on an obstetrical practice group's website and/or on LinkedIn.[12] The physician's photograph was used to code their race and sex. Of the 1,582 physicians observed delivering babies in New Jersey over our sample period, we were able to gather information on race and sex for 1,120 (70.8 percent). Among these physicians, 624 were female (55.7 percent), 137 were Black (12.2 percent), and 110 were Black females (9.8 percent).

Lastly, we use hospital discharge data linked to the EBC records to assess impacts on maternal and infant health (Gemmill et al., 2024). We consider postpartum maternal health to be poor if any of the following conditions occur up to 90 days following the delivery: postpartum hemorrhage, major puerperal infection, venous complications, pyrexia, pulmonary embolism, and other postnatal complications. We consider infant health at birth to be poor if any of these complications are present: admission to a NICU, 5-minute Apgar score below 7, mechanical ventilation, and significant birth injury.[13] Because of changes in how complications have been coded over time, we restrict attention to the period 2008–2015 when considering health outcomes.

Predicting C-section risk We use detailed information about medical risk factors available in the EBC records to determine each mother's appropriateness for a C-section.[14] To do so, we use all 993,165 births over our sample period and a random forest algorithm.[15]

[11]Information on the EBC records come from a medical form that is completed by a medical practitioner and a background form that is completed by the mother. Variables such as medical risk factors and method of delivery come from the former, whereas race, education, and marital status come from the latter.

[12]This method follows Singh and Venkataramani (2022). Information on practice group could not be coded for 37 percent of doctors. Specifications that control for practice group therefore include fewer observations than our primary sample.

[13]Results are very similar if we further consider measures of low birth weight.

[14]We use the following risk factors: age, diabetes, obesity, preeclampsia, eclampsia, chronic hypertension, previous C-section, breech presentation, placenta previa, placenta abruption, cardiac disease, renal disease, cord prolapse, birth order, multiple births, herpes, drug misuse, excessive weight gain, anemia, RH sensitization, and macrosomia. See Table A1 for means of these risk factors by race.

[15]Compared to a model with a single decision tree, a random forest is less likely to be affected by outliers and overfitting. Compared to a logit, a random forest is more flexible in that it is not necessary to choose interaction terms manually.

The algorithm creates multiple individual decision trees, each using a random set of medical risk factors and a bootstrap subsample of births from a training sample with half of the sample births. The algorithm parameters, such as the number of trees and the number of medical factors in the random subset, are chosen by minimizing the "out-of-bag" error (i.e., the classification error for the subsamples in the training sample that are not included in a tree). The final random forest has 1,000 trees and randomly selects five medical risk factors for each tree. The predicted C-section risk for each mother is then computed by averaging the predictions over the decision trees.

The random forest produces credible results that are strongly predictive of actual delivery method. Table A2 reports the importance of each risk factor in predicting the probability of having a C-section, where "importance" measures how much information the model gains from all splits of the trees that are made based on a given risk factor. Reassuringly, factors that are known to be important determinants of C-section appropriateness, such as previous C-section and breech presentation, stand out as important risk factors. Moreover, we examine how well this measure of C-section risk predicts whether a mother has a C-section in Table A3. Births in the testing sample are sorted into deciles based on predicted C-section risk, and the actual and predicted C-section rate for each decile is reported. Comparing these rates by decile shows that the model does an excellent job sorting mothers into risk groups.

Sample restrictions We make three sample restrictions to arrive at our primary analysis sample. First, in most of what follows, we focus on a sample of births among Black and non-Hispanic white mothers.[16] This reduces the sample to 646,656 births. Second, we limit the sample to births for which the attending provider was a physician (M.D. or D.O.) with a valid national provider identifier (NPI). This allows us to focus on the 549,834 births for which the provider could have performed a C-section. Lastly, our primary analysis sample excludes C-sections that were scheduled in advance and focuses on the 394,377 births that were unscheduled deliveries. Among the 394,377 unscheduled deliveries, 322,997 (81.9 percent) were vaginal deliveries and 71,380 (18.1 percent) were C-sections that occurred after a trial of labor.

[16] We also compare Hispanic and "other" (mostly Asian) mothers to white mothers in the appendix (see Table A7), although the starkest differences emerge between Black and white mothers.

Two factors motivate our focus on unscheduled deliveries. First, despite a lack of supporting evidence, there is a persistent belief that C-sections are driven by demand from mothers who want the convenience of a scheduled birth and want to avoid the pain of a potentially lengthy labor. As mothers who desire a C-section can find a provider willing to schedule one in advance (ACOG, 2019), excluding scheduled C-sections arguably focuses the sample on women who were not demanding C-sections. Second, as outlined in Section V.B and Appendix C, focusing on unscheduled deliveries allows us to exploit variation in the costs of ordering unscheduled C-sections driven by variation in the timing of scheduled C-sections to ask whether doctors view Black mothers as unobservably more in need of unscheduled C-sections.

Summary statistics Table 1 provides summary statistics by maternal race and delivery method. We provide statistics both for the 394,377 births included in our primary analysis sample ("Unscheduled deliveries") as well as all 549,834 births delivered by a physician with a valid NPI among Black and white mothers ("All births"). As shown in panel (a), 44.3 percent of births among Black mothers in New Jersey from 2008–2017 were delivered by C-section compared to 39.7 among white mothers. While rates of both scheduled and unscheduled C-sections are higher among Black mothers than white mothers, the racial gap is more pronounced for unscheduled C-sections.

C-section rates are higher among Black mothers despite the fact that Black mothers are predicted to be less in need of C-sections. As shown in panel (b), Black women on average have lower mean appropriateness for a C-section, especially when they have unscheduled deliveries. This result is largely because Black mothers tend to be considerably younger than white mothers (see Table A1), and maternal age is identified as an important risk factor for C-section by the random forest analysis (Table A2). While Black mothers are therefore over-represented in the lowest risk quintiles, panel (b) shows that average risk conditional on risk quintile is quite similar between Black and white mothers.[17]

[17] In Table 1 and in the subsequent analysis, risk quintiles are defined using the distribution of predicted risk among mothers with unscheduled C-sections. The reason for this choice is that our main focus is on unscheduled deliveries, and having an equal number of unscheduled C-sections in each quintile affords sufficient power to estimate the racial gap in unscheduled C-sections in each risk quintile. Figure A1 shows the distribution of maternal risk by race among unscheduled births.

Average maternal and infant health outcomes are shown in panel (c) of Table 1. Postpartum complications for mothers and postnatal complications for infants are less likely following unscheduled deliveries than for all births. This difference is to be expected since C-sections are frequently scheduled for the riskiest births. Notably, however, maternal and infant complications are more likely among Black mothers than among white mothers, both for all births and for the subset of deliveries that are unscheduled. Among unscheduled deliveries, 7.1 percent of Black mothers have at least one postpartum complication compared to only 5.9 percent of white mothers. Similarly, 11.2 percent of infants born to Black mothers with unscheduled deliveries have any postnatal complication compared to 7.1 percent among babies born to white mothers.

Black and white mothers further differ in terms of their sociodemographic characteristics and the characteristics of the providers that they see. As shown in panel (d) of Table 1, Black women are more likely to be covered by Medicaid, are less likely to have a college degree, and are less likely to be married than white women. Moreover, panel (e) shows that Black women are more than twice as likely to have an attendant physician who is Black (19.7 versus 8.6 percent). However, since most doctors are white, nearly half of all Black infants are delivered by white doctors. There is no apparent racial difference in the degree of attendant physicians (M.D. versus D.O.), although white women are somewhat more likely to have a female physician (47.3 versus 41.7 percent).

IV Racial disparities in C-section rates

Using data from the National Vital Statistics birth records, Figure 1 shows annual C-section rates among Black and non-Hispanic white mothers across the United States and in New Jersey from 2003 to 2018. While C-section rates in New Jersey are higher than the national average for white and Black mothers, a pronounced racial gap in C-section rates is evident both nationally and in New Jersey. Moreover, the racial gap in C-section rates began to widen in the mid-2000s as C-section rates for white mothers started to fall while those for Black mothers continued to rise for much of the period.[18]

[18] The fall in C-section rates among white mothers in New Jersey after 2007 and the slight decline among Black mothers in New Jersey after 2014 correspond to important ACOG announcements indicative of efforts

Figure 2 shows the share of New Jersey births delivered by C-section by maternal race and risk quintile in the EBC records.[19] Subfigure (a) uses the entire sample of births and plots the share of mothers in each race-risk group that have any C-section (scheduled or unscheduled). Subfigure (b) also uses the entire sample of births but plots the share of mothers in each race-risk group that have a scheduled C-section, whereas subfigure (c) focuses on unscheduled deliveries and plots the share of mothers with unscheduled C-sections. The right subplots in each subfigure provide the relative effect for Black mothers for each C-section type by risk quintile, which is calculated by dividing the difference in C-section rates between Black and white mothers by the C-section rate among white mothers.

Unsurprisingly, the left subplots in Figure 2 show that the share of mothers who deliver by C-section is increasing in the mother's appropriateness for the surgery. Notably, however, the probability of having any C-section (scheduled or unscheduled) is significantly higher for Black mothers in all but the highest risk quintile (Figure 2(a)). As shown in Figure 2(b), scheduled C-sections are more evenly distributed by race, though Black mothers are more likely to have scheduled C-sections in the third and fourth risk quintiles.

Hence, the higher C-section rate among low-risk Black mothers is primarily driven by unscheduled C-sections. As shown in Figure 2(c), Black mothers with unscheduled deliveries are more likely to deliver by C-section than white mothers across the risk distribution. Strikingly, Black mothers with unscheduled deliveries in the lowest risk quintile are 149.4 percent (p-value < 0.001) more likely to have a C-section than white mothers. The relative effect for Black mothers declines steeply with risk, although Black women with unscheduled deliveries in the highest risk quintile are still 12.3 percent (p-value $= 0.046$) more likely to deliver by C-section.

Figure A3 explores the relationship between weeks of gestation, C-section rates, and C-section risk. The left (right) subplots show average C-section rates (risk) by gestational age. As in Figure 2, subfigure (a) considers all C-sections (scheduled and unscheduled), subfigure (b) considers scheduled C-sections, and subfigure (c) considers unscheduled C-sections. The

to reduce C-section rates. In 2007, ACOG made a statement against conducting non-medically indicated C-sections before 39 weeks, while in 2014, ACOG issued guidelines aimed at preventing C-sections for first births by allowing women to labor for longer.

[19]Figure A2 shows an analogous figure by unweighted deciles of maternal risk (i.e., risk of 0–0.1, 0.1–0.2, etc.) rather than risk quintiles with equal numbers of unscheduled C-sections.

figure shows that Black mothers who have C-sections have systematically lower medical risk for the procedure than white mothers at all gestational ages.[20]

V Drivers of racial disparities in C-section rates

As outlined in Section II, racial disparities in C-section rates could be driven by a number of factors, including racial differences in maternal demand, maternal risk, maternal sociodemographics, selection into different providers, and/ or provider bias. In what follows, we focus on unscheduled C-sections to minimize the role of maternal demand (i.e., we focus on mothers who opted for a trial of labor rather than a scheduled C-section). Section V.A examines how racial disparities in unscheduled C-section rates change when controls for observable maternal risk, maternal sociodemographics such as education and Medicaid coverage, and selection into providers are included. Section V.B then considers the drivers of racial disparities in unscheduled C-section rates that persist among observationally equivalent mothers delivering in the same hospital, with a particular focus on the potential roles played by unobserved differences in medical risk and provider discretion.

V.A Conditioning on controls

To explore the importance of observable characteristics of the mother and selection into providers, we leverage the detailed nature of our data to estimate specifications of the following form:

$$\begin{aligned} C\text{-}section_{idmyhpg} =& \beta \cdot Black_i + \delta \cdot Day\ of\ week_d + \gamma_{my} \\ &+ \alpha \cdot X_i + \gamma_h + \gamma_g + \gamma_p + \epsilon_{idmyhpg}, \end{aligned} \tag{1}$$

[20]Figure A3 further shows that Black mothers are less likely than white mothers to have a C-section before 37 weeks. However, only a small share of babies are born before this point, and Black mothers become more likely to have unscheduled C-sections after 37 weeks and scheduled C-sections after 39 weeks. The medical risk for C-section among those receiving scheduled C-sections falls abruptly after 39 weeks, suggesting that more scheduled C-sections before 39 weeks have medical risk factors that indicate a strong need for a C-section. In contrast, the medical risk for unscheduled C-sections among those receiving them declines steadily with gestational age.

where $C\text{-}section_{idmyhpg}$ is an indicator denoting whether mother i giving birth on day d in month m and year y in hospital h with physician p from practice group g had a C-section, $Black_i$ is an indicator denoting Black mothers, $Day\ of\ week$ is a full set of day-of-week fixed effects, and γ_{my} are month-by-year fixed effects.[21] We progressively add additional controls to the specification to examine how their inclusion changes the association between race and the probability of having a C-section. In particular, we include a vector of maternal characteristics including predicted medical risk and the socioeconomic controls outlined in Table 1 (X_i) and fixed effects for hospital (γ_h), practice group (γ_g), and physician (γ_p). Standard errors are clustered by hospital. The sample is restricted to unscheduled deliveries among Black and white mothers, and thus β captures the differential probability that Black mothers with unscheduled deliveries have a C-section relative to white mothers. In much of what follows, we divide β by the mean unscheduled C-section rate among white mothers to derive the relative effect for Black mothers.

Results from estimation of equation (1) are shown in Table 2. Column (1) reports the baseline disparity (i.e., including only controls for day of the week and month-by-year fixed effects). The estimate indicates that Black mothers with unscheduled deliveries are 4.2 percentage points more likely to deliver by C-section than white mothers. Compared to the average rate of unscheduled C-sections among white mothers (16.9 percent), the estimate indicates that Black mothers with unscheduled deliveries have a 24.8 percent (p-value $=$ 0.005) higher probability of delivering by C-section than their white counterparts.

Columns (2)–(6) of Table 2 show how the relative effect for Black mothers changes as the controls in equation (1) are progressively added to the specification. Since Black women are predicted to have lower medical risk on average, controlling for medical risk increases the relative effect for Black mothers from 24.8 to 37.0 percent (column (2)). Controlling for the mother's health insurance, marital status, and education reduces the relative effect to 26.2 percent, indicating that some of the gap can be explained by differences in socioeconomic characteristics (column (3)). Controlling for the hospital of delivery further reduces the gap from 26.2 to 21.0 percent (column (4)). Once hospital fixed effects are added, controlling

[21] We control for day of the week because C-sections—both scheduled and unscheduled—are significantly less common on weekends (see Figure A4).

for the provider's practice or the individual provider has little further impact. The fully saturated model in column (6) indicates that the same physician treating observably similar women in the same hospital is 20.1 percent (p-value < 0.001) more likely to perform an unscheduled C-section on a Black mother than on a white mother.

To examine how individual physicians treat mothers who are observably similar except for their race, Figure 3 plots provider-specific propensities to perform unscheduled C-sections on Black mothers against the same provider's propensity to perform unscheduled C-sections on white mothers. These propensities come from estimation of an analogue of equation (1) that includes all the controls in column (6) of Table 2 and interacts the physician fixed effect with separate indicators for whether the mother is Black or white. As shown in Figure 3, most sample physicians have a higher propensity to perform unscheduled C-sections on Black mothers than on observationally similar white mothers (i.e., the points are above the 45-degree line). Although the points begin to move below the 45-degree line for doctors who perform unscheduled C-sections on a very high share of white mothers, over 70 percent of all unscheduled births (75 percent of unscheduled births for Black mothers) over the sample period were delivered by physicians who were more likely to perform unscheduled C-sections on Black mothers.

Since controlling for the provider's practice or the individual provider is found to have little impact, and practice group could not be determined for all providers, our preferred specification moving forward excludes γ_g and γ_p from equation (1). The last column of Table 2 shows estimates from this preferred specification using all births and focusing on scheduled C-sections as the outcome. While Black mothers are more likely to have both scheduled and unscheduled C-sections, the relative effect for Black mothers is much smaller for scheduled C-sections (11.7 percent, p-value < 0.001). As women with scheduled C-sections frequently have some risk factors that make them appropriate candidates for a C-section, this result is in line with the finding in Figure 2 that the racial gap in C-section rates is larger among lower risk mothers.

An alternative way to control for maternal characteristics is to estimate equation (1) separately on subsamples of the data defined by insurance, education, and marital status. As shown in Table A4, Black women with unscheduled deliveries have higher probabilities of delivering by C-section in each category. The relative effect for Black mothers varies from 13.5 percent for unmarried women to 27 percent for college-educated women. Similarly, Table A5 shows additional splits of the data by when prenatal care began, child parity, and whether the hour of delivery is during normal business hours. Notably, Black woman with unscheduled births of higher parity are 46 percent more likely to have a C-section than white mothers. The relative effect for Black mothers is slightly higher during normal business hours compared to at night (22.7 versus 18.2 percent), a pattern that is consistent with additional C-sections being done on Black mothers when resources are readily available. Table A5 also shows estimates that include a control for whether labor was induced or stimulated, as well as fixed effects for the zip code of the mother as an additional indicator of socioeconomic status. The estimates are very similar with these additional controls.

Of course, there might be unobservable characteristics of mothers that correlate with race and affect a doctor's propensity to perform a C-section. In Section V.B below, we examine the role of differences in unobserved medical risk by exploiting variation in the costs of ordering unscheduled C-sections due to fluctuations in capacity. Here, we apply the intuition outlined in Altonji et al. (2005) and Oster (2019) to consider the potential importance of unobservables in our setting. As shown in the first three columns of Table 2, controlling for maternal medical risk and sociodemographic variables increases the gap between white and Black mothers, implying that selection on unobservables would have to be of opposite sign compared to selection on observables to explain the relationship between maternal race and the probability of having an unscheduled C-section. This is true even when first controlling for selection into hospitals: as shown in Table A6, the relative effect for Black mothers increases from 16.0 percent to 21.0 percent when conditioning on observable maternal characteristics in specifications with hospital fixed effects. Standard tests of selection on unobservables therefore suggest that unobservable maternal characteristics are unlikely to be important in explaining racial differences in delivery method, in line with our findings in Section V.B below.

Equation (1) implicitly assumes that the effect of race is the same across the risk distribution. To allow the effects of race to vary with maternal risk (as in Figure 2), we estimate the following extension of equation (1):

$$C\text{-}section_{idmyh} = \sum_{q\in[1,4]} \alpha_q \cdot R_i^q + \sum_{q\in[1,5]} \beta_q \cdot R_i^q \cdot Black_i \\ + \delta \cdot Day\ of\ week_d + \gamma_{my} + \alpha \cdot X_i + \gamma_h + \epsilon_{idmyh}, \tag{2}$$

where R_i^q is an indicator for whether mother i is in risk quintile q. As in equation (1), we gradually add the additional controls to examine how the estimated racial disparities change across the risk distribution when observable characteristics of the mother and selection into different providers is taken into account.

Results from estimation of equation (2) are plotted in Figure 4.[22] Recall from Figure 2(c) that the baseline disparity in C-section rates is more pronounced among mothers with lower predicted risk of needing a C-section, with Black mothers with unscheduled deliveries in the lowest risk quintile being 149.4 percent (p-value < 0.001) more likely to have a C-section than white mothers. Although there are slight differences in C-section risk by race within each risk quintile grouping, Black mothers in the lowest risk quintile are still 137.6 percent (p-value < 0.001) more likely to have an unscheduled C-section when controlling for a continuous measure of C-section risk. Further controlling for socioeconomic status of the mother reduces the relative effect of being Black for the lowest risk mothers from 137.6 to 89.3 percent. Hence, in an accounting sense, about one-third of the baseline disparity for low-risk mothers can be "explained" by factors such as maternal education, insurance, and marital status, though it is unclear why these factors should be important in the C-section decision once medical risk is taken into account. Moreover, even conditional on these controls and hospital fixed effects, low-risk Black mothers are still 63.3 percent more likely than white mothers to have an unscheduled C-section (p-value $= 0.002$). In the highest risk quintile, the relative effect for Black mothers is reduced from 12.3 to 7.9 percent conditional on these controls and is only significant at the 10 percent level (p-value $= 0.082$).

[22] The estimates underlying Figure 4 are shown in Table A8.

V.B Exploiting variation in costs

There are at least two potential explanations for racial disparities in unscheduled C-section rates that persist conditional on a rich set of patient controls and provider fixed effects. First, even though we are able to observe more information about mothers than is typically available to researchers, there could be differences in unobservable risk factors that are correlated with race, affect a mother's appropriateness for a C-section, and are only observed by doctors. Put differently, Black mothers might be unobservably (to the econometrician) riskier than the random forest algorithm predicts. Alternatively, it could be that providers are exercising their discretion and are more likely to conduct unnecessary C-sections on Black mothers.

To separate these two potential explanations, we exploit variation in the costs of ordering unscheduled C-sections generated by the timing of scheduled C-sections. If an obstetrical unit has only a few operating theaters that are designated for C-sections, then the costs of ordering a C-section will be higher when those theaters are already in use. If persistent gaps in unscheduled C-section rates are driven by unobservables, and Black patients are unobservably more in need of C-sections than their white counterparts, then providers should reduce unscheduled C-sections more among white mothers conditional on observed medical risk when the costs of ordering a C-section rise. In this case, the racial gap in unscheduled C-section rates will be *higher* at times when there is a scheduled C-section. In contrast, if the persistent gap is driven by provider discretion, with unscheduled C-sections undergone by Black patients being less necessary than those undergone by white patients, then doctors should cut back on C-sections among Black mothers more when the costs rise. That is, the racial gap in unscheduled C-sections should be *lower* when there are scheduled C-sections. Appendix C outlines a conceptual framework that formalizes this intuition.

Figure 5 shows the distribution of scheduled and unscheduled C-sections across hours of the day. Scheduled C-sections are most likely to happen early in the day, with the probability falling fairly continuously throughout the day and leveling off by midnight. Unscheduled C-sections, on the other hand, rise throughout the day as scheduled C-sections fall, reaching a peak around 8pm and then declining until 7am.

To formalize the connection between the timing of scheduled and unscheduled C-sections, we examine how the probability of having an unscheduled C-section changes when there is a scheduled C-section at the same hour as the unscheduled delivery. As shown in Table A10, mothers are 9.5 percentage points—or 52.4 percent of the outcome mean of 18.1 percent—less likely to deliver by unscheduled C-section when there is a concurrent, scheduled C-section. Notably, unscheduled C-sections are also significantly less likely in the hour before and the hour after a scheduled C-section, indicating that clinicians do not simply push back procedures of either type in response to the other.[23] Moreover, as shown in Table A11, the trade-off between scheduled and unscheduled C-sections is very similar when the data are aggregated to the hospital-day or even to the hospital-week level, further indicating that unscheduled C-sections are not just deferred to a time when there is no scheduled C-section (or vice-versa). These patterns highlight how the timing of scheduled C-sections affect decisions about whether to order unscheduled C-sections and suggest that medical necessity is not the only driver of unscheduled C-section rates.

To examine how the racial gap changes when the costs of ordering an unscheduled C-section are higher, we estimate an analogue of equation (1) that allows the effect of being Black to vary depending on whether there was a scheduled C-section in the same hospital at the hour of delivery. In particular, letting $C\text{-}section_{idmyho}$ denote a C-section for mother i giving birth at hour o on day d in month m and year y at hospital h, we estimate specifications of the following form:

$$\begin{aligned} C\text{-}section_{idmyho} =& \beta_1 \cdot Black_i + \beta_2 \cdot Scheduled_{dmyho} + \beta_3 \cdot Black_i \cdot Scheduled_{dmyho} \\ & + \delta \cdot Day\ of\ week_d + \alpha \cdot X_i + \gamma_{my} + \gamma_h + \epsilon_{idmyho}, \end{aligned} \tag{3}$$

where $Scheduled_{dmyho}$ denotes whether there was a concurrent, scheduled C-section.[24] All other variables are defined as in equation (1), and standard errors are again clustered by hospital.

[23] There is some evidence that unscheduled C-sections are somewhat more likely two hours before and after a scheduled C-section. However, the impacts are substantially smaller than the reductions in the three-hour window surrounding the scheduled procedure (i.e., hours -1, 0 and 1), leading to aggregate reductions in unscheduled C-sections on days and in weeks with more scheduled procedures (Table A11).

[24] We use an indicator variable instead of the number of scheduled C-sections because less than 8 percent of hospital-day-hours with a scheduled C-section in our data have more than one.

Estimates of equation (3) are reported in the first column of Table 3. When there is no scheduled C-section at the hour of delivery, 17.7 percent of white mothers with unscheduled deliveries deliver by C-section. Black mothers with unscheduled deliveries are 3.8 percentage points more likely to deliver by C-section in the same situation, meaning that Black mothers are 21.2 percent more likely to have an unscheduled C-section than white mothers when there is no concurrent, scheduled C-section. When there is a concurrent, scheduled C-section, the rate of unscheduled C-sections falls for both white and Black mothers. Only 9.0 percent of white mothers with unscheduled deliveries deliver by C-section when the birth occurs at the same time as a scheduled C-section. Strikingly, however, the rate of unscheduled C-sections falls by an additional 2.8 percentage points for Black mothers, leading the relative effect of being Black to fall from 21.2 percent (p-value < 0.001) to an insignificant 12.5 percent (p-value $= 0.370$).

Figure 6 presents estimates from an extension of equation (3) that allows the effect of race and risk quintile to vary by whether there was a concurrent, scheduled C-section (as in equation (2)).[25] The figure shows that the higher probability that a low-risk Black mother has an unscheduled C-section first shown in Figure 2(c) is entirely accounted for by patients delivering when there is no scheduled C-section. When there are scheduled C-sections, there is no statistically significant elevation in the risk of an unscheduled C-section for low-risk Black women.

V.C Additional analyses

To explore the role of racial and gender concordance between doctors and patients, we estimate analogues of equation (3) that include indicators for whether the physician is Black or female in place of the indicator denoting whether the birth occurred at the same time as a scheduled C-section. For example, letting $Black_p$ be an indicator for whether physician p

[25] The coefficient estimates underlying Figure 6 are shown in Table A9.

is Black, we estimate the following equation:

$$C\text{-}section_{idmyhp} = \beta_1 \cdot Black_i + \beta_2 \cdot Black_p + \beta_3 \cdot Black_i \cdot Black_p + \delta \cdot Day\ of\ week_d + \alpha \cdot X_i + \gamma_{my} + \gamma_h + \epsilon_{idmyhp}, \tag{4}$$

to ask whether the racial gap is more or less pronounced when patients are treated by Black doctors. We further estimate versions that replace $Black_p$ with an indicator denoting whether the physician is female to see whether the racial gap is different among female physicians.

Results from estimation of equation (4) are shown in Table 3. Column (2) shows that Black doctors are just as likely to perform unscheduled C-sections as doctors of other races. Although the difference is not statistically significant, we find some evidence that Black doctors are less likely to perform additional C-sections on Black mothers: the relative effect for Black mothers is 22.3 percent (p-value < 0.001) among patients treated by non-Black physicians and only 14.9 percent (p-value < 0.001) among patients treated by Black doctors. Looking to column (3), although female doctors are slightly less likely to perform unscheduled C-sections, we find no evidence that the racial gap is different between female and male doctors.

Up to this point we have focused on differences between Black and non-Hispanic white mothers. Table A7 provides estimates comparing non-Black Hispanic (column (2)) and "Other race" mothers (column (3)) to non-Hispanic white mothers. In New Jersey, the other race category is 80 percent Asian, but also includes Native Americans, Pacific Islanders, and people who self-classify as "other." Hispanics and other race mothers are also more likely to have unscheduled C-sections than non-Hispanic white mothers, although the racial gap is most pronounced when comparing Black and white mothers.

VI Impacts on maternal and fetal health

An important question is whether differences in C-section rates among Black and white mothers have associated health effects. We examine the health impacts of delivery method by estimating extensions of equation (3) that use measures of poor postpartum maternal and infant health as dependent variables. That is, we exploit plausibly exogenous variation in the probability of having an unscheduled C-section driven by the timing of scheduled C-sections to investigate how marginal C-sections affect maternal and infant health.

The predicted impacts of additional C-sections on patient health differ by maternal risk and with the drivers of differences in C-section rates. If additional C-sections performed on low-risk women are unnecessary, then reducing the number of these procedures should either have no effects or improve health. If, on the other hand, these apparently low-risk women have unobservable risk factors that make them good candidates for a C-section, then reductions in unscheduled C-sections for them should worsen health. The calculus is the opposite for high-risk mothers: reductions in C-sections among those who need the procedure should be associated with a deterioration in health outcomes, unless they are actually poor candidates for the procedure.

To investigate these predictions, we group births into those that are relatively low risk (risk quintiles 1-3; $Risk^L$) and those that are relatively high risk (risk quintiles 4 and 5; $Risk^H$). Let $Health_{idmyho}$ denote poor health of a mother (baby) i giving birth (being born) at hour o on day d in month m and year y at hospital h. We estimate the following specification for Black and white mothers separately:

$$\begin{aligned} Health_{idmyho} = {} & \alpha_L \cdot Risk_i^L + \eta_L \cdot Scheduled_{dmyho} \cdot Risk_i^L \\ & + \eta_H \cdot Scheduled_{dmyho} \cdot Risk_i^H + \delta \cdot Day\ of\ week_d \\ & + \alpha \cdot X_i + \gamma_{my} + \gamma_h + \epsilon_{idmyho}, \end{aligned} \tag{5}$$

where X_i includes maternal sociodemographics and all individual medical risk factors, and all other variables are defined as in equation (3). As before, we restrict the sample to unscheduled births and cluster standard errors by hospital. As outlined in Section III, we consider indicators for poor postpartum maternal health and poor infant health at birth as dependent variables.[26] We further consider each index component separately as an outcome

[26] Recall that we consider a mother to have poor postpartum health if she has postpartum hemorrhage, major puerperal infection, venous complications, pyrexia, pulmonary embolism, or other complications in the 90 days following delivery. We consider an infant to have poor health at birth if the baby was admitted to a NICU, had a 5-minute Apgar score below 7, required mechanical ventilation, or had a significant birth injury.

to examine which complications drive impacts on maternal and infant health. Because of changes in how complications have been coded over time, these analyses are conducted using information on 283,893 sample births between 2008–2015 that meet the sample inclusion criteria.

Results from estimation of equation (5) are presented in Table 4. As the specification and sample period are slightly different than in Table 3, columns (1) and (2) first confirm that both Black and white mothers with unscheduled births are significantly less likely to have an unscheduled C-section when the birth occurs at the same time as a scheduled C-section. Although the reduction in unscheduled C-section rates is similar for high-risk Black and white mothers, the reduction in unscheduled C-sections among mothers with the lowest risk of needing the procedure is more pronounced among Black mothers.

Columns (3) and (4) of Table 4 consider the impacts of concurrent, scheduled C-sections on the postpartum health of Black and white mothers with unscheduled deliveries, respectively. The interactions between risk quintile groupings and the indicator denoting whether the birth took place at the same time as a scheduled C-section show that reductions in unscheduled C-sections stemming from reduced capacity do not significantly affect the index measure of poor postpartum health among Black mothers. However, results for individual index components shown in Table A12 reveal that low-risk Black mothers are 0.5 percentage points (17.9 percent, p-value = 0.016) less likely to have other postpartum complications—predominately "disruption of Cesarean wound/perineal wound/obstetrical surgical wounds" (ICD-9 674.1-3)—when the unscheduled delivery occurs at the same time as a scheduled C-section. Similarly, Table A12 shows that low-risk white mothers experience a 0.3 percentage point (16.6 percent, p-value = 0.003) reduction in such complications when the unscheduled delivery coincides with a scheduled C-section. This effect drives an overall reduction in postpartum complications among low-risk White mothers with unscheduled deliveries of 0.5 percentage points (9.3 percent, p-value = 0.036) in column (4) of Table 4. These findings are noteworthy, as reductions in *necessary* C-sections stemming from reductions in capacity would be expected to negatively affect maternal health.[27]

[27] Results from a two-stage least squares analogue of equation (5) using measures of maternal postpartum health as the outcome are shown in Table A13. In line with Tables 4 and A12, results show that low-risk white mothers are significantly more likely to have any postpartum complication when they have a marginal

Impacts on infant health are shown in columns (5) and (6) of Table 4 for children born to Black and white mothers, respectively. The interactions between risk categories and the indicator denoting whether the birth took place at the same time as a scheduled C-section show that low-risk Black infants are 1.2 percentage points (13.0 percent, p-value = 0.008) less likely to have any postnatal complications when the hospital is more constrained while white infants are 0.9 percentage points (16.6 percent, p-value = 0.017) less likely. Results by individual index components shown in Table A14 reveal that these improvements in infant health are driven by reductions in the probability of admission to the NICU. In contrast, column (6) of Table 4 shows that infants born to high-risk white mothers are 1.6 percentage points (12.2 percent, p-value = 0.022) more likely to have poor health at birth when the birth occurs at the same time as a scheduled C-section, an effect that is driven by increased NICU admissions (see Table A14).[28] Thus, the results suggest that the marginal C-sections done on low-risk Black and white mothers because there is the capacity for doctors to do so harms infant health. Moreover, reductions in C-sections among high-risk mothers when the hospital is more constrained harm the health of white infants. These findings suggest that unscheduled C-sections are better targeted among high-risk white mothers than among Black mothers at baseline.

VII Discussion and conclusions

This paper sheds light on the drivers of the well-documented racial disparity in C-section rates. On average, Black mothers with an unscheduled delivery are 24.8 percent more likely to have an unscheduled, or "emergency," C-section. This difference cannot be eliminated by controlling for observable medical risk factors or differences in socioeconomic characteristics, though including controls for these variables closes some of the gap. And while the racial gap is reduced by the inclusion of hospital and doctor fixed effects, a significant racial gap

C-section. Moreover, white mothers are 4.0 percentage points (p-value = 0.003) and Black mothers are 4.5 percentage points (p-value = 0.010) more likely to have other postpartum complications when they have marginal C-sections, reflecting increases of 252.1 and 198.7 percent of the respective baseline means.

[28] Two-stage least squares results presented in Table A15 mirror these reduced-form findings. Strikingly, marginal C-sections among low-risk white and Black mothers are shown to increase the probability that the infant has poor health at birth by 13.0 percentage points (246.0 percent, p-value = 0.024) and 11.1 percentage points (126.2 percent, p-value = 0.014), respectively.

remains. Even when treated by the same physician in the same hospital, Black mothers with unscheduled deliveries are 20.1 percent more likely than observationally similar white mothers to deliver by C-section.

The persistent racial gap in treatment raises the question of whether it can be accounted for by unobservable differences between Black and white mothers. One possible difference is in terms of demand for C-sections. To reduce the possibility that racial gaps are driven by Black mothers being more likely to request C-sections, we focus on unscheduled deliveries. Another possible difference is unobservable risk factors. If Black mothers are unobservably better candidates for C-sections than observationally similar white mothers, then physicians should reduce unscheduled C-sections more among white mothers with similar observable risk when reduced capacity causes the costs of ordering an unscheduled C-section to rise. In this case, the racial gap would grow in the face of increased costs. In contrast, we find that the racial disparity shrinks when the costs of ordering an unscheduled C-section are higher due to the unscheduled delivery taking place at the same time as a scheduled C-section. This finding is consistent with doctors being more willing to do unnecessary C-sections on Black mothers when there is the capacity to do so.

Impacts on maternal and fetal health further suggest that differences in unobserved health risk are unlikely to explain the racial disparity in delivery method. If Black mothers whom we characterize as low risk for a C-section have unobservable risk factors that make them good candidates for the procedure, then Black mothers and their infants should suffer differentially when reduced capacity leads to reductions in unscheduled C-sections. Strikingly, however, the sizable reductions in unscheduled C-sections that occur among Black mothers when the costs of ordering an unscheduled C-section rise have no negative effects on the health of Black mothers or their infants. In contrast, the results indicate that preventing marginal C-sections in low-risk mothers has positive health effects for infants of both races, reduces overall postpartum complications among white mothers, and reduces complications involving the C-section wound among Black mothers. Moreover, only infants born to high-risk white mothers with unscheduled births are more likely to have postnatal complications when capacity is limited, suggesting that unscheduled C-sections are better targeted among high-risk white mothers when doctors are unconstrained.

If racial gaps in C-section rates are not accounted for by either observable or unobservable patient characteristics, then why do providers treat similar mothers differently? We investigate the role of physician gender but find no evidence that female physicians are less likely to treat patients differently. We find suggestive evidence that Black doctors are less likely to do additional C-sections on Black mothers, although these analyses are limited in statistical power given the small number of Black physicians in our sample. The results point to the importance of provider discretion and suggest that many doctors simply set a lower threshold for performing unscheduled C-sections on Black mothers. Further research is needed to determine whether this differential treatment reflects lack of care, communication barriers, cultural misunderstandings, or other factors so that the disparity can be effectively addressed.

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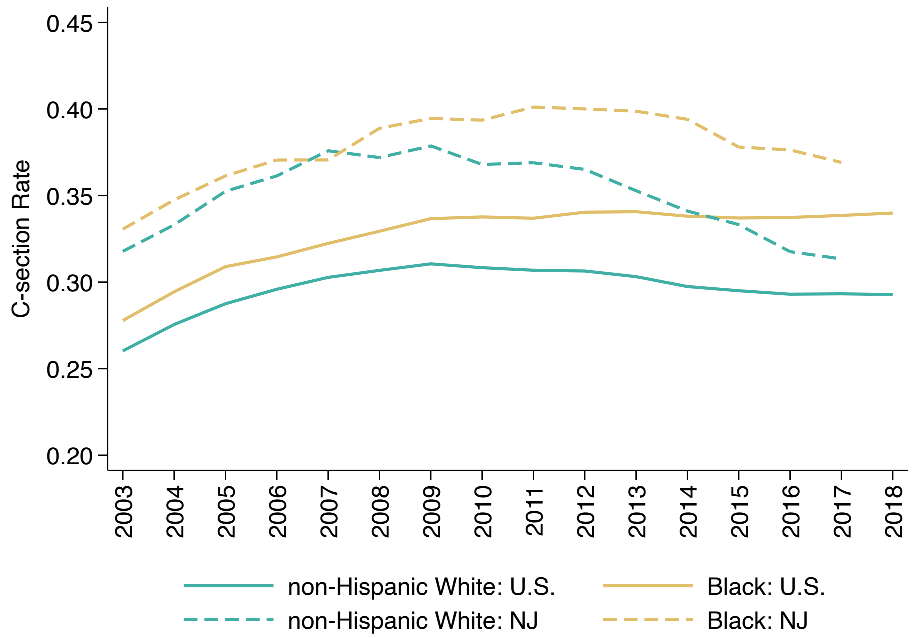
VIII Figures

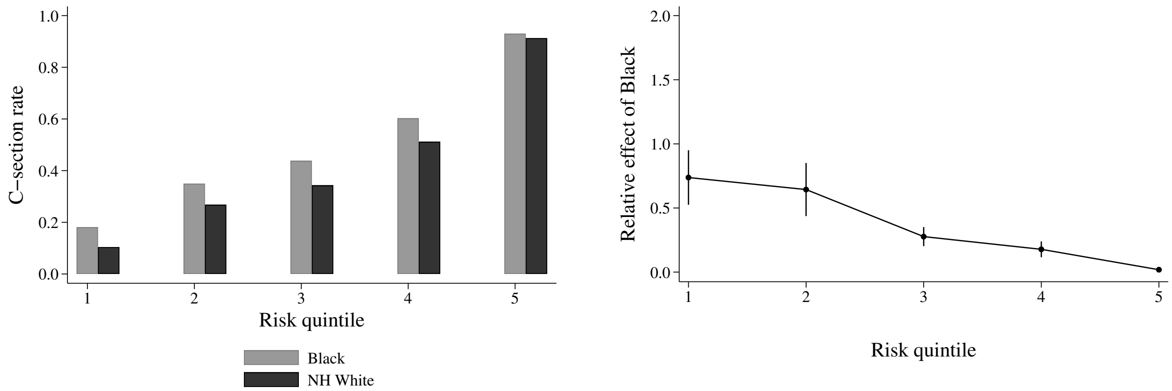
Figure 1: C-section rates by race in the United States and in New Jersey



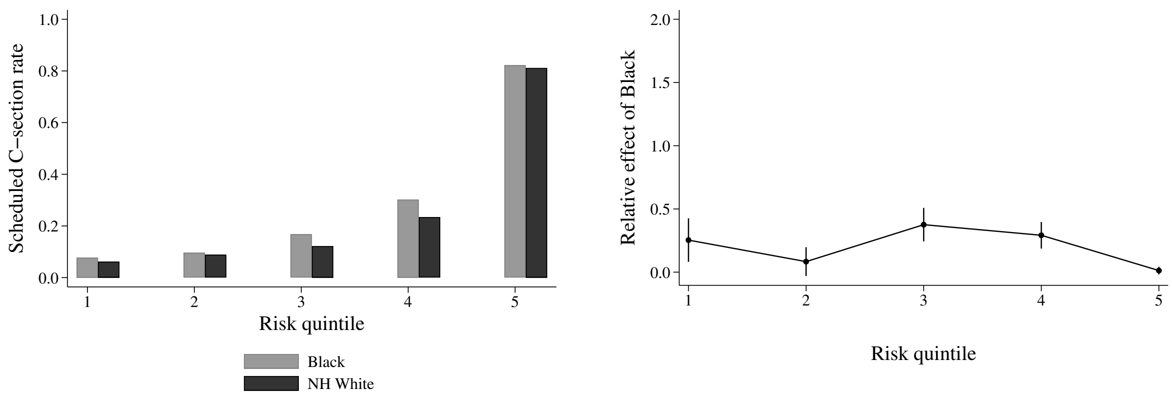
Notes: The above figure shows the share of births delivered by C-section across the United States (solid lines) and in New Jersey (dashed lines) from 2003 to 2018. These rates are shown separately for non-Hispanic white mothers (teal lines) and Black mothers (yellow lines). Data come from the National Vital Statistics birth data.

Figure 2: Raw disparities in C-section rates across risk quintiles

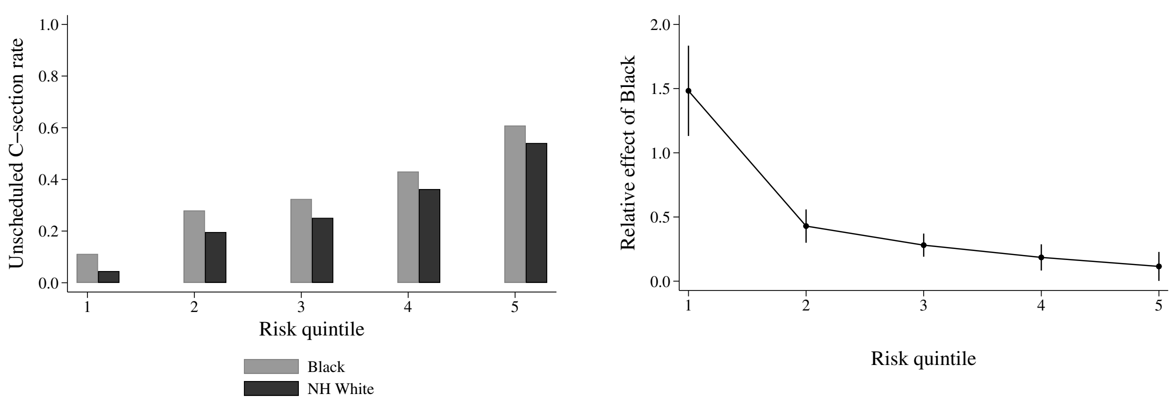
(a) All C-sections



(b) Scheduled C-sections

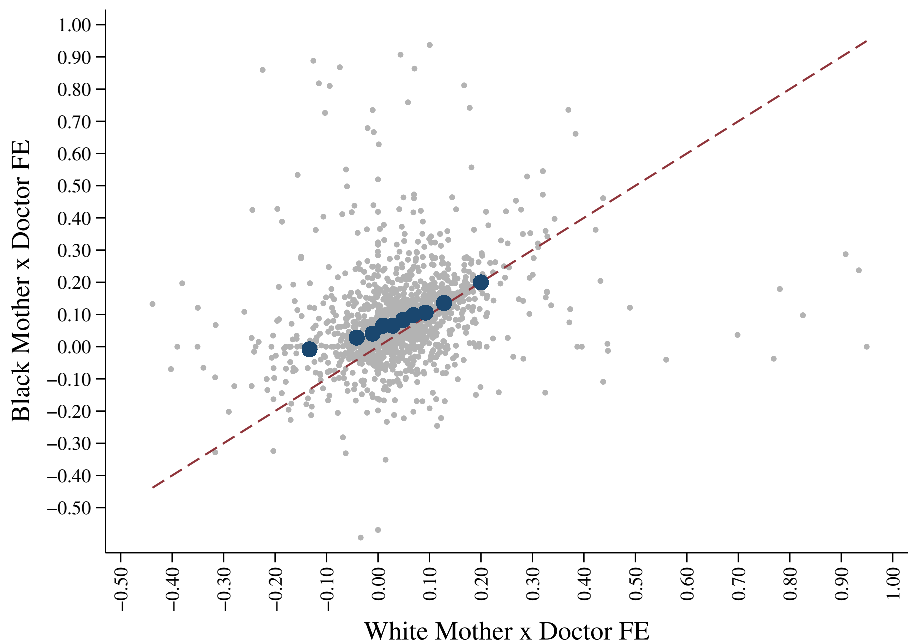


(c) Unscheduled C-sections



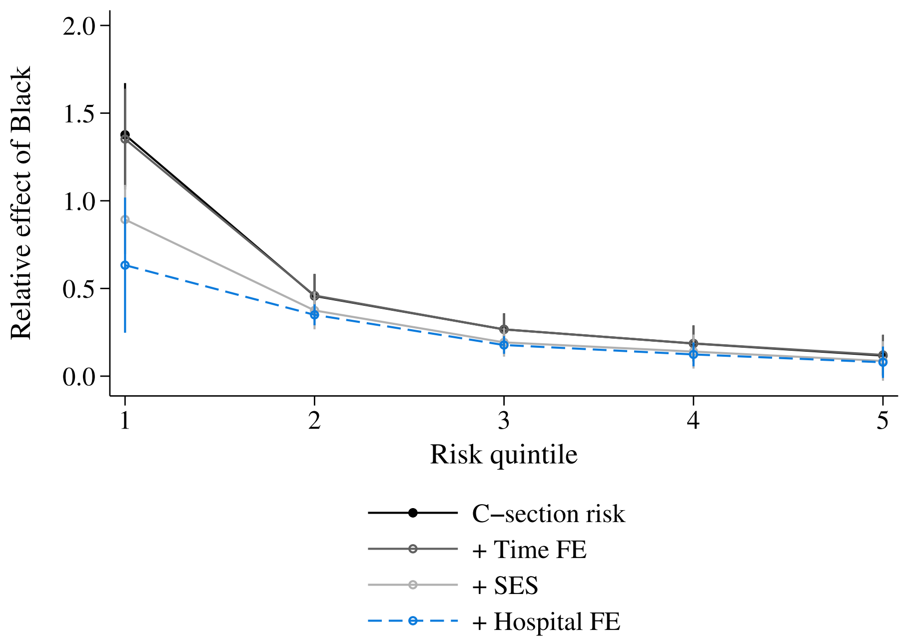
Notes: The above figures show the disparity in the share of births delivered by C-section by maternal race and risk quintile. The left subplots show raw C-section rates in each race-risk group; the right subplots show the relative effect for Black mothers and the associated 95 percent confidence intervals, where the relative effect for Black mothers is the difference in Black and non-Hispanic white rates divided by the non-Hispanic white rate. All births are included in subfigures (a) and (b); only unscheduled deliveries are included in subfigure (c). See page 11 for a description of how mothers are separated into risk quintiles. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017.

Figure 3: Provider-specific C-section propensities by race



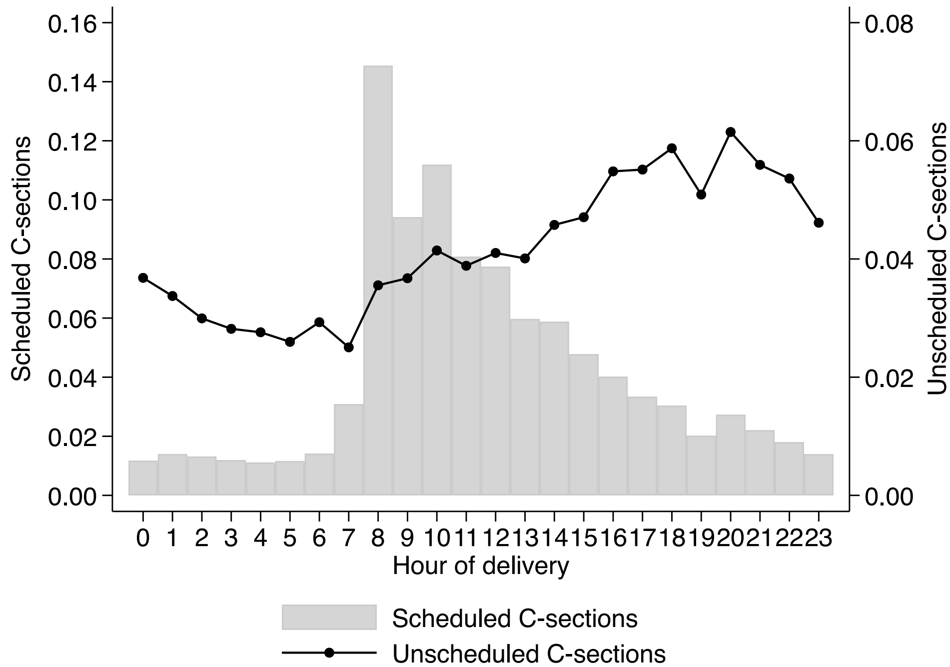
Notes: The above figure shows the association between provider-specific propensities to perform C-sections on Black and white mothers. Each small, gray dot represents an individual provider and plots the provider's race-specific fixed effects from estimation of an analogue of equation (1) that interacts the physician fixed effect with both an indicator denoting whether the mother is Black and an indicator denoting whether the mother is white. As in column (6) of Table 2, the regressions further control for C-section risk, maternal SES, and year-month, day-of-week, and hospital fixed effects. The larger, blue dots plot the weighted average of coefficients in each decile of white C-section propensities, where the weights are given by the total number of births delivered by each physician over the sample period. The dashed, red line reflects the 45 degree line. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017.

Figure 4: Unscheduled C-section disparities: conditional on maternal and hospital characteristics



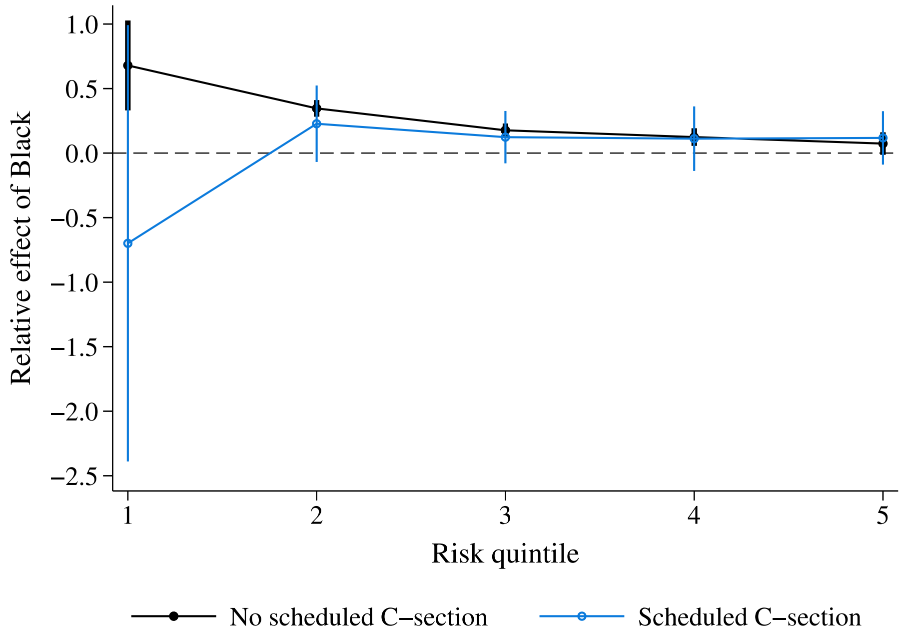
Notes: The above figure shows the relative effect for Black mothers and the associated 95 percent confidence intervals derived from estimation of equation (2). Only unscheduled births are included in these regressions, and the outcome is an indicator for whether the mother had an unscheduled C-section. The relative effect for Black mothers is calculated by dividing the estimated coefficient on Black by the relevant mean among non-Hispanic white mothers. The following controls are progressively added to the specification: time fixed effects (year-month and day-of-week fixed effects); markers of the mother's socioeconomic status ("SES") including education, martial status, and an indicator for Medicaid coverage; and hospital fixed effects. All regressions include a control for continuous C-section risk in addition to indicators denoting C-section risk quintiles; see page 11 for a description of how mothers are separated into risk quintiles. The underlying coefficients and standard errors are provided in Table A8. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017.

Figure 5: Distribution of hour of delivery for scheduled and unscheduled C-sections



Notes: The above figure shows the distributions of scheduled C-sections (bars) and unscheduled C-sections (solid line) by hour of delivery. Only births during weekdays are included; see Figure A4 for the distribution of scheduled C-sections across weekends and weekdays. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017.

Figure 6: Unscheduled C-section disparities: with and without concurrent, scheduled C-section



Notes: The above figure shows the relative effect for Black mothers and the associated 95 percent confidence intervals derived from estimation of an analogue of equation (3). Only unscheduled births are included in the regression, and the outcome is an indicator for whether the mother had an unscheduled C-section. The relative effects of being Black are calculated by dividing the estimated coefficients on Black interacted with or without an indicator denoting whether there was a concurrent, scheduled C-section by the relevant mean among non-Hispanic white mothers. The regression includes controls for time fixed effects (year-month and day-of-week fixed effects); markers of the mother's socioeconomic status ("SES") including education, martial status, and an indicator for Medicaid coverage; and hospital fixed effects. The regression further includes a control for continuous C-section risk in addition to indicators denoting C-section risk quintiles; see page 11 for a description of how mothers are separated into risk quintiles. The underlying coefficients and standard errors are provided in Table A9. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017.

IX Tables

Table 1: Summary statistics by maternal race and delivery method

	Unscheduled deliveries		All births	
	Black (1)	White (2)	Black (3)	White (4)
a. C-section rates				
Total C-section rate			0.443	0.397
Scheduled C-section rate			0.294	0.276
Unscheduled C-section rate	0.211	0.169	0.149	0.122
b. C-section risk				
Average C-section risk	0.237	0.265	0.382	0.400
Quintile 1 (r $<$ 0.24)	0.117	0.110	0.117	0.111
Quintile 2 (0.24 $<$ r $<$ 0.30)	0.270	0.279	0.270	0.279
Quintile 3 (0.30 $<$ r $<$ 0.41)	0.346	0.341	0.347	0.341
Quintile 4 (0.41 $<$ r $<$ 0.68)	0.514	0.515	0.522	0.519
Quintile 5 (0.68 $<$ r $<$ 1)	0.865	0.862	0.898	0.904
c. Maternal and infant health				
Maternal postpartum complication	0.071	0.059	0.077	0.060
Infant postnatal complication	0.112	0.071	0.132	0.084
d. Mother sociodemographic characteristics				
Medicaid	0.504	0.163	0.500	0.151
Less than BA	0.783	0.443	0.776	0.435
BA or graduate degree	0.211	0.553	0.218	0.561
Married	0.314	0.811	0.341	0.821
e. Attendant physician characteristics				
Non-Hispanic White	0.473	0.704	0.473	0.707
Black	0.197	0.086	0.194	0.083
Female	0.417	0.473	0.403	0.460
M.D.	0.885	0.860	0.888	0.864
Observations	112,620	281,757	159,685	390,149

Notes: The above table provides summary statistics for the 394,377 births included in the primary analysis sample ("Unscheduled deliveries") as well as all 549,834 births delivered by a physician with a National Provider Identifier (NPI) to mothers who were Black or non-Hispanic white ("White"). See page 11 for a description of how C-section risk is assigned to each mother. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017. Because of changes in how complications have been coded over time, panel (c) restricts attention to the 393,286 births (283,893 unscheduled) over the period 2008 to 2015.

Table 2: Racial gap in unscheduled C-sections: role of maternal characteristics and health care resources

	Unscheduled C-section						Scheduled C-section
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Black mother	0.042***	0.062***	0.044***	0.035***	0.033***	0.034***	0.032***
	(0.014)	(0.010)	(0.008)	(0.003)	(0.003)	(0.003)	(0.004)
C-section risk		0.714***	0.718***	0.711***	0.715***	0.706***	0.949***
		(0.034)	(0.037)	(0.043)	(0.045)	(0.043)	(0.015)
Observations	394,377	394,377	394,377	394,377	330,602	394,283	549,834
Adjusted R-squared	0.007	0.161	0.163	0.174	0.187	0.189	0.117
Mean outcome: white mothers	0.169	0.169	0.169	0.169	0.169	0.169	0.276
Relative effect of Black	0.248***	0.370***	0.262***	0.210***	0.197***	0.201***	0.117***
	(0.084)	(0.058)	(0.048)	(0.019)	(0.016)	(0.016)	(0.014)
Year-month FEs	X	X	X	X	X	X	X
Day-of-week FEs	X	X	X	X	X	X	X
Mother SES			X	X	X	X	X
Hospital FEs				X	X	X	X
Practice FEs					X		
Doctor FEs						X	

Notes: The above table presents coefficients and standard errors (in parentheses) from estimation of equation (1). Only unscheduled births are included in columns (1)–(6), and the outcome is an indicator for whether the mother had an unscheduled C-section. All births (scheduled and unscheduled) are included in column (7), and the outcome is an indicator for whether the mother had a scheduled C-section. "Maternal SES" includes indicators for maternal education, marital status, and Medicaid coverage. Standard errors are clustered by hospital. The relative effect for Black mothers is calculated by dividing the estimated coefficient on Black by the mean outcome among non-Hispanic white mothers. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017. *** denotes p-values < 0.01, ** denotes p-values < 0.05, * denotes p-values < 0.10.

Table 3: Racial gap in unscheduled C-sections: role of capacity and concordance

	Unscheduled C-section		
	(1)	(2)	(3)
Black mother	0.038***	0.037***	0.035***
	(0.003)	(0.004)	(0.004)
Scheduled CS	-0.087***		
	(0.009)		
Black mother x Scheduled CS	-0.028**		
	(0.011)		
Black doctor		-0.001	
		(0.007)	
Black mother x Black doctor		-0.009	
		(0.007)	
Female doctor			-0.006*
			(0.003)
Black mother x female doctor			-0.001
			(0.007)
Observations	394,377	354,316	354,316
Adjusted R-squared	0.178	0.175	0.175
Mean outcome among white mothers			
No scheduled CS	0.177		
Non-Black doctor		0.166	
Male doctor			0.170
Relative effect of being Black			
Scheduled CS	0.125		
	(0.139)		
No scheduled CS	0.212***		
	(0.018)		
Black doctor		0.149***	
		(0.034)	
Non-Black doctor		0.223***	
		(0.023)	
Female doctor			0.209***
			(0.026)
Male doctor			0.209***
			(0.032)

Notes: The above table presents coefficients and standard errors (in parentheses) from estimation of equation (3) (column (1)) and variants of equation (4) (columns (2)–(3)). Only unscheduled births are included, and the outcome is an indicator for whether the mother had an unscheduled C-section. All regressions include year-month, day-of-week, and hospital fixed effects and controls for maternal C-section risk and SES. "Scheduled CS" is an indicator denoting whether there was at least one scheduled C-section at the hour of the unscheduled delivery in the same hospital. Standard errors are clustered by hospital. The relative effect for Black mothers is calculated by dividing the estimated coefficient on Black by the relevant mean among non-Hispanic white mothers. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017. *** denotes p-values < 0.01, ** denotes p-values < 0.05, * denotes p-values < 0.10.

Table 4: Effects of concurrent, scheduled C-sections on maternal and infant health

	Unscheduled C-section		Maternal postpartum complication		Infant postnatal complication	
	Black (1)	White (2)	Black (3)	White (4)	Black (5)	White (6)
Scheduled CS x quintile 1-3	-0.118***	-0.083***	-0.000	-0.005**	-0.012***	-0.009**
	(0.010)	(0.011)	(0.004)	(0.002)	(0.004)	(0.004)
Scheduled CS x quintile 4-5	-0.169***	-0.173***	-0.014	0.004	-0.007	0.016**
	(0.030)	(0.030)	(0.013)	(0.005)	(0.016)	(0.007)
Observations	83,202	200,691	83,202	200,691	83,202	200,691
Adjusted R-squared	0.163	0.184	0.013	0.009	0.106	0.106
Mean outcome without scheduled C-section						
Quintile 1-3	0.184	0.133	0.066	0.055	0.095	0.057
Quintile 4-5	0.538	0.457	0.104	0.079	0.213	0.132
Relative effect of scheduled C-section						
Quintile 1-3	-0.644***	-0.626***	-0.005	-0.093**	-0.130***	-0.166***
	(0.056)	(0.082)	(0.059)	(0.044)	(0.047)	(0.066)
Quintile 4-5	-0.315***	-0.377***	-0.132	0.045	-0.035	0.122**
	(0.056)	(0.066)	(0.130)	(0.060)	(0.073)	(0.053)

Notes: The above table presents coefficients and standard errors (in parentheses) from estimation of equation (5). Only unscheduled births are included. In columns (3) and (4), the outcome is an indicator for whether the mother experienced any of the following complications in the 90 days following delivery (ICD-9 in parentheses): postpartum hemorrhage (666), major puerperal infection (670), venous complications (671), pyrexia (672), pulmonary embolism (673), and other postpartum complications (674). In columns (5) and (6), the dependent variable is an indicator for whether the infant experienced any of the following complications: admission to the NICU, 5-minute Apgar score below 7, infant needing mechanical ventilation, and significant birth injury. Results by individual index components of maternal and infant health are provided in Tables A12 and A14, respectively. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2015. *** denotes p-values < 0.01, ** denotes p-values < 0.05, * denotes p-values < 0.10.

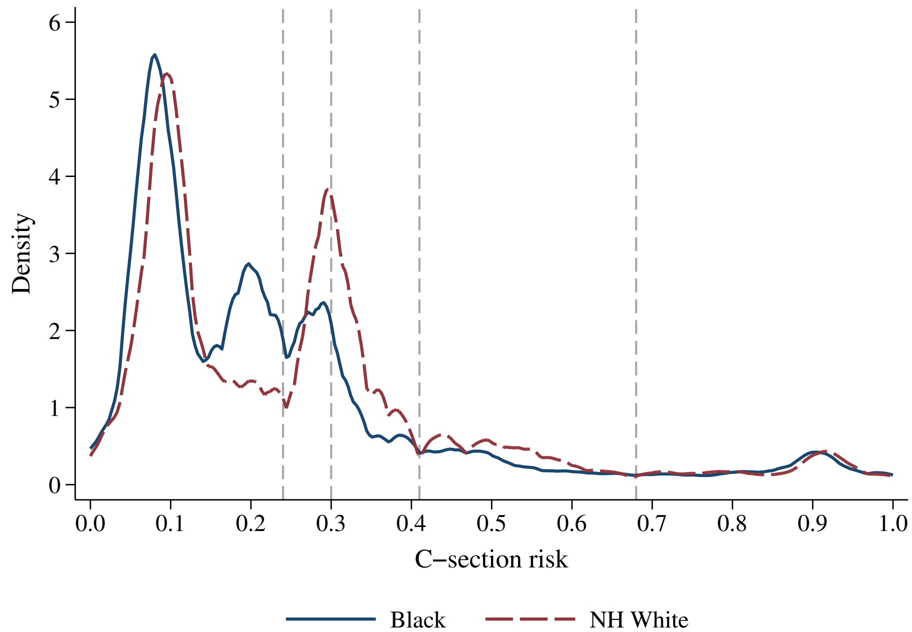
For Online Publication

Drivers of Racial Differences in C-Sections

Corredor-Waldron, Currie, and Schnell (2024)

A Supplementary figures

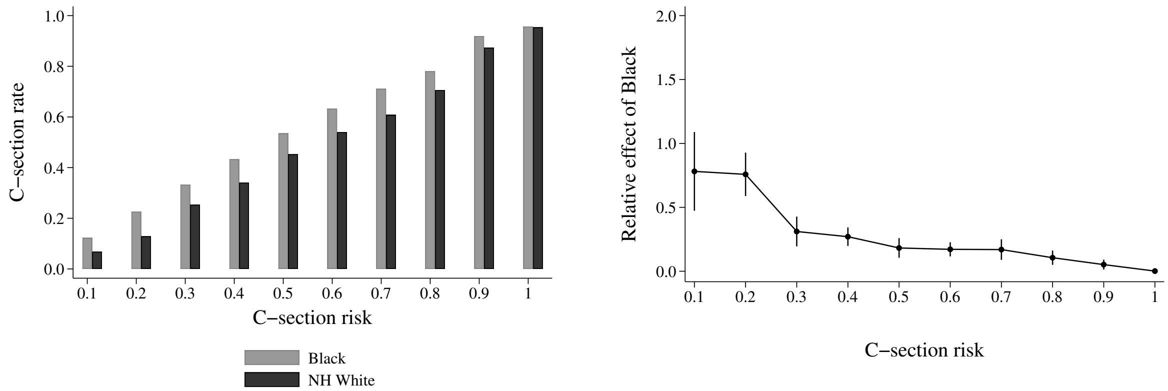
Figure A1: Distribution of maternal risk by race among unscheduled births



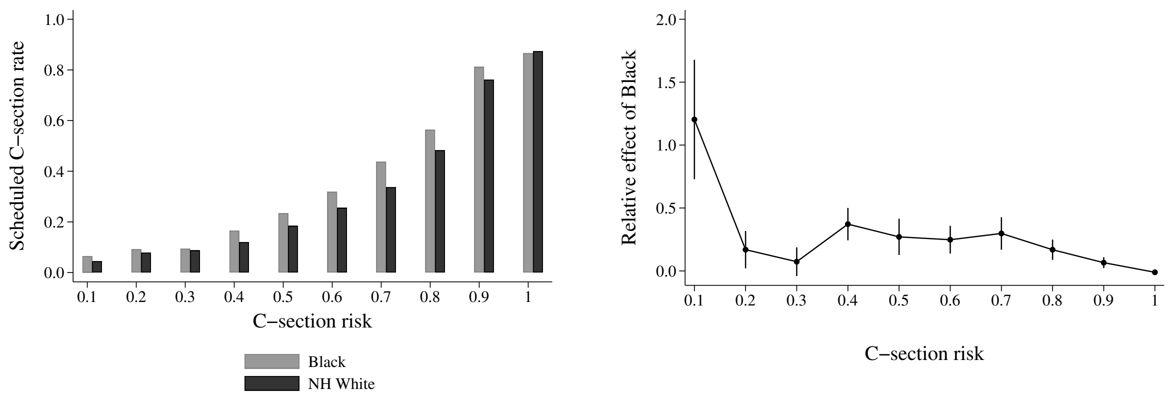
Notes: The above figure shows the distribution of medical appropriateness for a C-section ("risk") among unscheduled deliveries by race. The distribution is shown separately for white mothers (dashed, red line) and Black mothers (solid, blue line). The vertical lines denote the quintile cut-offs used in the analysis; as outlined in the text, these risk quintiles are defined using the distribution of predicted risk among mothers with unscheduled C-sections (rather than all unscheduled deliveries). See page 11 for a description of how C-section risk is assigned to each mother. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017.

Figure A2: Raw disparities in C-section rates across risk deciles

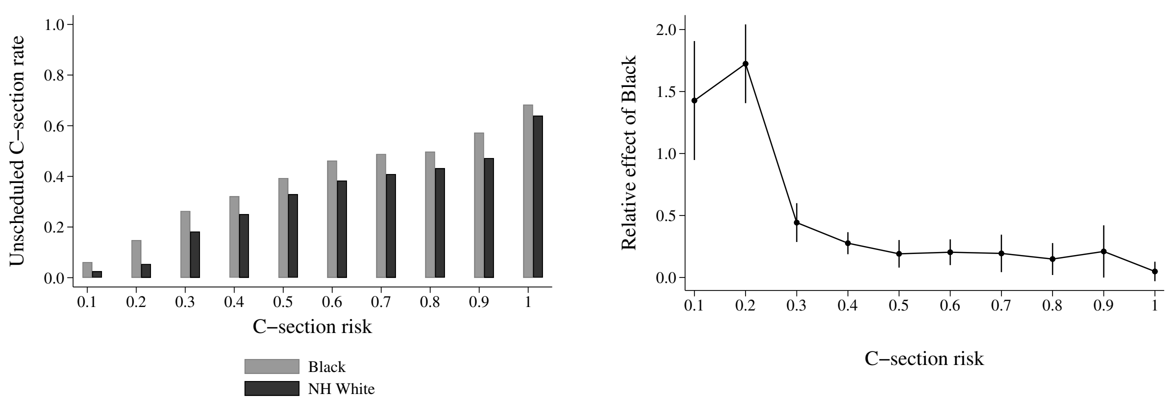
(a) All C-sections



(b) Scheduled C-sections



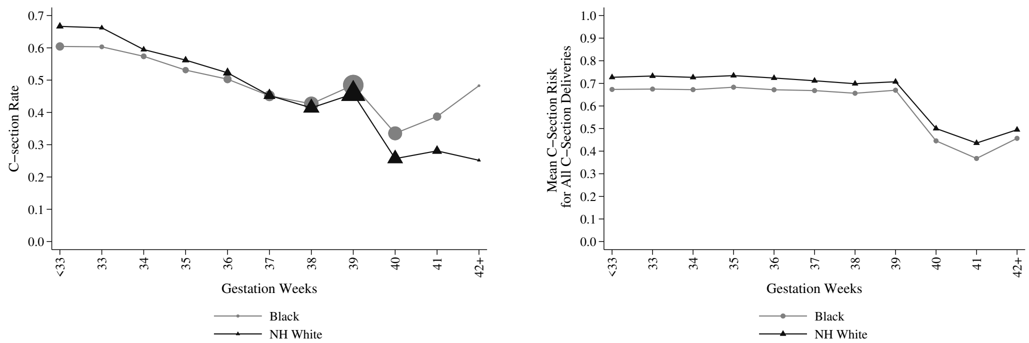
(c) Unscheduled C-sections



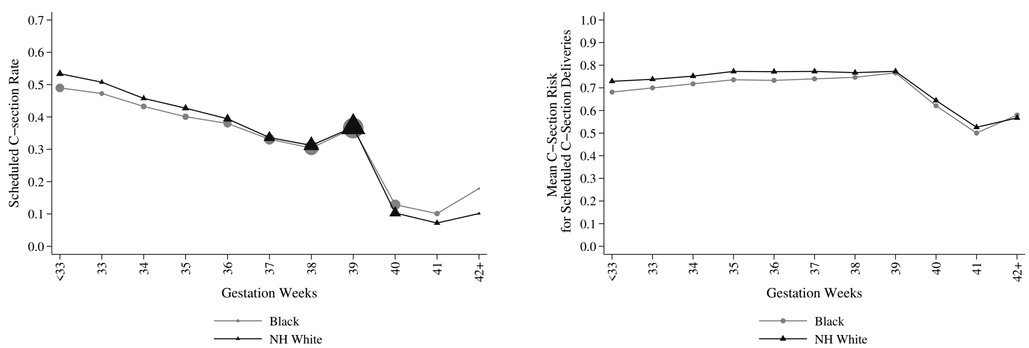
Notes: The above figures show the disparity in the share of births delivered by C-section by maternal race and risk decile. The left subplots show raw C-section rates in each race-risk group; the right subplots show the relative effect for Black mothers and the associated 95 percent confidence intervals, where the relative effect for Black mothers is the difference in Black and non-Hispanic white rates divided by the non-Hispanic white rate. All births are included in subfigures (a) and (b); only unscheduled deliveries are included in subfigure (c). For this figure only, mothers are separated into unweighted risk deciles each covering 10 percent of the range of potential risk (i.e., 0–0.1, 0.1–0.2, etc.). Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017.

Figure A3: Average C-section rates and risk by race and gestation weeks

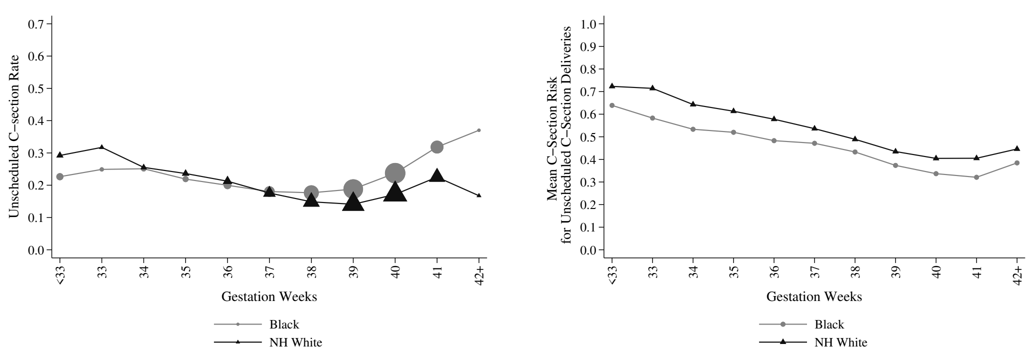
(a) All C-sections



(b) Scheduled C-sections

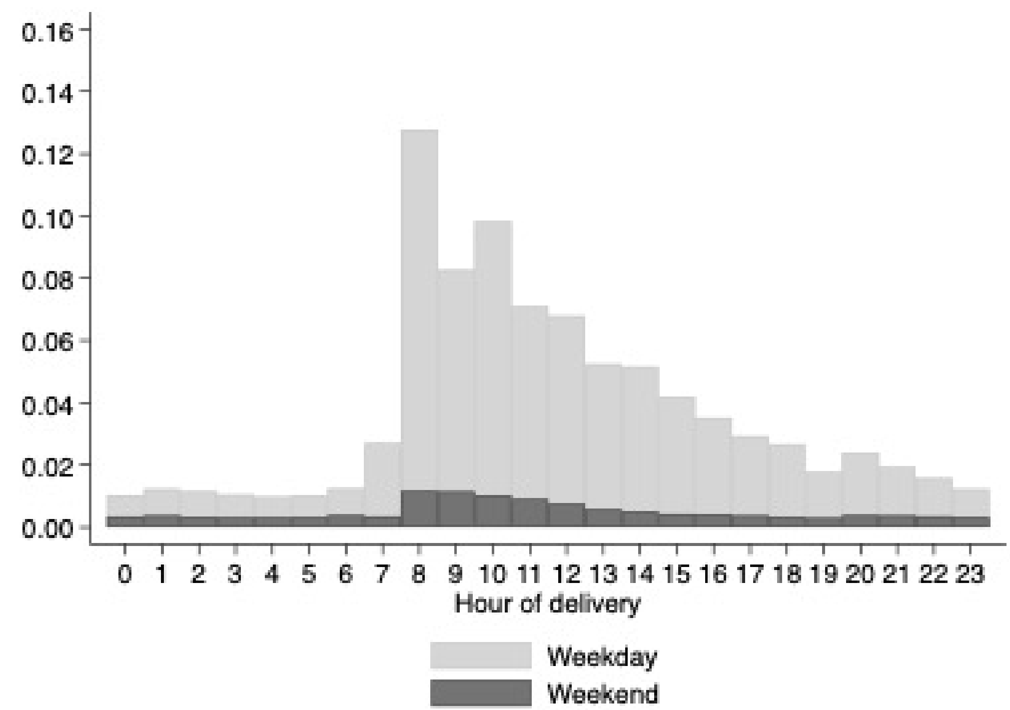


(c) Unscheduled C-sections



Notes: The above figures show the share of births delivered by C-section (left subfigures) and the average maternal risk for a C-section among births delivered by C-section (right subfigures) by maternal race and gestational weeks at delivery. All births are included in subfigures (a) and (b); only unscheduled deliveries are included in subfigure (c). Figures are shown for non-Hispanic white mothers (dark series) and for Black mothers (light series). See page 11 for a description of how C-section risk is assigned to each mother. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017.

Figure A4: Timing distribution of scheduled C-sections: weekends versus weekdays



Notes: The above figure shows the distribution of scheduled C-sections by hour of delivery across weekends (dark bars) and weekdays (light bars). Only scheduled C-sections are included; see Figure 5 for the distribution of scheduled and unscheduled C-sections by hour of delivery on weekdays. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017.

B Supplementary tables

Table A1: C-section risk and medical risk factors by race

	non-Hispanic white (1)	Black (2)	non-Black Hispanic (3)	Other race (4)
C-section risk	0.262	0.236***	0.221***	0.278***
Medical risk factors				
Macrosomia	0.089	0.048***	0.064***	0.034***
Weight gain: 60+ pounds	0.033	0.043***	0.027***	0.013***
Obesity	0.034	0.053***	0.034	0.008***
Age <20	0.015	0.087***	0.074***	0.006***
Age [20,25)	0.116	0.272***	0.245***	0.056 ***
Age [25-30)	0.245	0.269***	0.281***	0.273***
Age [30-34]	0.370	0.220***	0.241***	0.423***
Age 35+	0.255	0.152***	0.159***	0.242***
Birth order = 1	0.477	0.454***	0.430***	0.558***
Birth order = 2	0.299	0.278***	0.293***	0.338***
Birth order = 3	0.129	0.153***	0.166***	0.079***
Birth order = 4+	0.094	0.114***	0.111***	0.025***
Previous C-section	0.029	0.035***	0.030	0.032***
Previous pre-term birth	0.011	0.018***	0.014***	0.008***
Plural	0.021	0.019***	0.011***	0.013***
Breech	0.014	0.015	0.013***	0.014
Herpes	0.009	0.017***	0.009***	0.003***
Placenta previa	0.001	0.001	0.001	0.001
Placenta abruptia	0.004	0.006***	0.005***	0.004
Cord prolapse	0.001	0.002	0.002	0.002
Eclampsia	0.001	0.001***	0.001**	0.0004
Chronic hypertension	0.009	0.026***	0.008***	0.007***
Hypertension during pregnancy	0.033	0.052***	0.033	0.024***
Cardiac disease	0.009	0.006***	0.004***	0.003***
Diabetes	0.040	0.043***	0.059***	0.106***
Anemia	0.026	0.065***	0.045***	0.030***
Renal disease	0.005	0.003***	0.004***	0.002***
RH sensitization	0.006	0.004***	0.003***	0.002***
Drug misuse	0.015	0.029***	0.011***	0.002***
Observations	281,757	112,620	147,770	77,675

Notes: The above table provides summary statistics for C-section risk and medical risk factors among mothers with unscheduled deliveries (vaginal or C-section). The primary analysis sample focuses on the 394,377 births to non-Hispanic white and Black mothers shown in the first two columns. As outlined on page 11, C-section risk is assigned to each mother using a random forest algorithm and the medical risk factors shown above. The stars in columns (2)–(4) denote differences relative to non-Hispanic white mothers (column (1)); *** denotes p-values < 0.01, ** denotes p-values < 0.05, and * denotes p-values < 0.10. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017.

Table A2: Importance of variables in the random forest models

Medical risk factor	Importance
Previous C-section	1.000
Mother's age	0.581
Birth order	0.581
Breech	0.401
Plural	0.392
Diabetes	0.367
Obesity	0.351
Macrosomia	0.309
Hypertension during pregnancy	0.304
Anemia	0.295
Previous Preterm	0.274
Chronic hypertension	0.254
Drug misuse	0.198
Weight gain: 60+ pounds	0.179
Cardiac disease	0.154
Placenta abruptia	0.150
Renal disease	0.142
Herpes	0.141
RH sensitization	0.114
Placenta previa	0.113
Eclampsia	0.095
Cord prolapse	0.087

Notes: The above table shows the importance of each risk factor in predicting the probability of having a C-section. "Importance" measures how much information the model gains from all the splits of the trees that are made based on the given risk factor. See page 11 for more information on the procedure used to assign C-section risk to each mother.

Table A3: Performance of random forest in testing sample

C-section risk percentile (1)	Mean C-section risk (2)	C-section rate (3)
1	0.051	0.066
2	0.087	0.093
3	0.107	0.108
4	0.166	0.170
5	0.253	0.249
6	0.304	0.307
7	0.380	0.384
8	0.647	0.650
9	0.897	0.897
10	0.957	0.935
Observations	496,583	

Notes: The above table shows the relationship between the average predicted probability of having a C-section ("C-section risk") and the average realized C-section rate in each decile of predicted C-section risk. Only deliveries in the testing sample are included; that is, we do not include births in the training sample for the random forest algorithm when constructing this table. See page 11 for more information on the procedure used to assign C-section risk to each mother.

Table A4: Racial gap in unscheduled C-sections: heterogeneity by maternal socioeconomic characteristics

	Payer		Education			Marital status	
	Medicaid (1)	Non-Medicaid (2)	HS or less (3)	Some college (4)	College+ (5)	Married (6)	Non-Married (7)
Black mother	0.030***	0.037***	0.027***	0.033***	0.047***	0.041***	0.028***
	(0.005)	(0.003)	(0.005)	(0.004)	(0.004)	(0.004)	(0.003)
C-section risk	0.676***	0.721***	0.700***	0.718***	0.712***	0.698***	0.743***
	(0.063)	(0.038)	(0.052)	(0.048)	(0.038)	(0.050)	(0.034)
Observations	102,701	291,676	125,962	86,940	179,628	263,962	130,415
Adjusted R-squared	0.174	0.175	0.169	0.177	0.177	0.189	0.146
Mean outcome: white	0.128	0.177	0.158	0.169	0.173	0.160	0.205
Relative effect of Black	0.233***	0.212***	0.170***	0.195***	0.270***	0.255***	0.135***
	(0.040)	(0.016)	(0.029)	(0.024)	(0.022)	(0.024)	(0.014)

Notes: The above table presents coefficients and standard errors (in parentheses) from estimation of a version of equation (1) that excludes practice group and physician fixed effects. Only unscheduled births are included, and the outcome is an indicator for whether the mother had an unscheduled C-section. All regressions include year-month, day-of-week, and hospital fixed effects and controls for maternal C-section risk and SES (education, marital status, and Medicaid coverage) excluding the variable used to split the sample. The subgroup observations by education do not sum to the total sample size because maternal education is missing from some birth records; we include an indicator denoting missing education when controlling for education in our primary specifications. Standard errors are clustered by hospital. The relative effect for Black mothers is calculated by dividing the estimated coefficient on Black by the relevant mean among non-Hispanic white mothers. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017. *** denotes p-values < 0.01, ** denotes p-values < 0.05, * denotes p-values < 0.10.

Table A5: Racial gap in unscheduled C-sections: additional heterogeneity and robustness

	First prenatal visit		Birth order		Hour of delivery		Additional controls	
	< 4 months	4+ months	First birth	Second+ birth	8am-8pm	9pm-7am	Induction/ stimulation	Zip Code FEs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Black mother	0.037***	0.034***	0.052***	0.034***	0.038***	0.031***	0.038***	0.031***
	(0.004)	(0.007)	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)
C-section risk	0.713***	0.682***	0.740***	0.605***	0.721***	0.692***	0.707***	0.710***
	(0.047)	(0.044)	(0.029)	(0.053)	(0.040)	(0.047)	(0.046)	(0.041)
Observations	294,198	27,621	185,655	208,722	238,364	156,010	323,932	394,372
Adjusted R-squared	0.175	0.148	0.086	0.240	0.180	0.167	0.181	0.175
Mean outcome: white	0.180	0.159	0.272	0.075	0.168	0.170	0.179	0.169
Relative effect of Black	0.204***	0.216***	0.190***	0.460***	0.227***	0.182***	0.213***	0.184***
	(0.020)	(0.042)	(0.016)	(0.039)	(0.021)	(0.022)	(0.020)	(0.018)

Notes: The above table presents coefficients and standard errors (in parentheses) from estimation of a version of equation (1) that excludes practice group and physician fixed effects. Only unscheduled births are included, and the outcome is an indicator for whether the mother had an unscheduled C-section. All regressions include year-month, day-of-week, and hospital fixed effects and controls for maternal C-section risk and SES (education, marital status, and Medicaid coverage). The subgroup observations by month of first prenatal visit do not sum to the total sample size because the starting month of prenatal care is missing from some birth records. Standard errors are clustered by hospital. The relative effect for Black mothers is calculated by dividing the estimated coefficient on Black by the relevant mean among non-Hispanic white mothers. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017. *** denotes p-values < 0.01, ** denotes p-values < 0.05, * denotes p-values < 0.10.

Table A6: Role of observable maternal characteristics on racial gap

	Without hospital fixed effects		With hospital fixed effects	
	(1)	(2)	(3)	(4)
Black	0.042***	0.044***	0.027***	0.035***
	(0.014)	(0.008)	(0.004)	(0.003)
C-section risk		0.718***		0.711***
		(0.037)		(0.043)
Observations	394,377	394,377	394,377	394,377
Adjusted R-squared	0.002	0.159	0.001	0.152
Mean outcome: white mothers	0.169	0.169	0.169	0.169
Relative effect of Black	0.248***	0.262***	0.160***	0.210***
	(0.084)	(0.048)	(0.024)	(0.019)
Year-Month FEs	X	X	X	X
Day-of-week FEs	X	X	X	X
Mother SES		X		X
Hospital FEs			X	X

Notes: The above table presents coefficients and standard errors (in parentheses) from estimation of equation (1). Only unscheduled births are included, and the outcome is an indicator for whether the mother had an unscheduled C-section. "Maternal SES" includes indicators for maternal education, marital status, and Medicaid coverage. Standard errors are clustered by hospital. The relative effect for Black mothers is calculated by dividing the estimated coefficient on Black by the mean outcome among non-Hispanic white mothers. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017. *** denotes p-values < 0.01, ** denotes p-values < 0.05, * denotes p-values < 0.10.

Table A7: Gaps in unscheduled C-sections by maternal race and ethnicity

	Unscheduled C-section		
	(1)	(2)	(3)
Maternal race:			
Black	0.035***		
	(0.003)		
Non-Black Hispanic		0.017***	
		(0.004)	
Other race			0.029***
			(0.005)
C-section risk	0.711***	0.714***	0.717***
	(0.043)	(0.043)	(0.044)
Observations	394,377	429,527	359,432
R-squared	0.174	0.174	0.174
Mean outcome: white mothers	0.169	0.169	0.169
Relative effect of race	0.210***	0.104***	0.171***
	(0.019)	(0.023)	(0.030)

Notes: The above table presents coefficients and standard errors (in parentheses) from estimation of a version of equation (1) that excludes practice group and physician fixed effects. Only unscheduled births are included, and the outcome is an indicator for whether the mother had an unscheduled C-section. All regressions include year-month, day-of-week, and hospital fixed effects and controls for maternal C-section risk and SES (education, marital status, and Medicaid coverage). For reference, column (1) reproduces column (4) from Table 2. Only non-Hispanic white mothers and mothers with the race/ethnicity being considered are included in each regression. Standard errors are clustered by hospital. The relative effect of each race/ethnicity is calculated by dividing the estimated coefficient by the relevant mean among non-Hispanic white mothers. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017. In these data, the "other race" category is 80 percent Asian and also includes American Indians, Pacific Islanders, and people who self-identified as "other." *** denotes p-values < 0.01, ** denotes p-values < 0.05, * denotes p-values < 0.10.

Table A8: Estimates underlying Figure 4

		No controls		C-section risk		+ Time FEs		+ Maternal SES		+ Hospital FEs	
	White mean	Coefficient	Relative effect	Coefficient	Relative effect	Coefficient	Relative effect	Coefficient	Relative effect	Coefficient	Relative effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Risk quintile 1	0.045	-0.497***		0.115***		0.108***		0.096***		0.071*	
		(0.037)		(0.024)		(0.024)		(0.025)		(0.036)	
Risk quintile 2	0.197	-0.345***		0.130***		0.124***		0.114***		0.088**	
		(0.036)		(0.025)		(0.025)		(0.026)		(0.036)	
Risk quintile 3	0.253	-0.289***		0.136***		0.132***		0.129***		0.106***	
		(0.037)		(0.024)		(0.024)		(0.025)		(0.034)	
Risk quintile 4	0.364	-0.178***		0.105***		0.104***		0.098***		0.084***	
		(0.034)		(0.026)		(0.026)		(0.026)		(0.030)	
Risk quintile 5	0.542										
Black x quintile 1		0.067***	1.494***	0.062***	1.376***	0.061***	1.352***	0.040***	0.893***	0.028***	0.633***
		(0.008)	(0.178)	(0.007)	(0.148)	(0.006)	(0.144)	(0.004)	(0.099)	(0.009)	(0.193)
Black x quintile 2		0.083***	0.423***	0.090***	0.458***	0.091***	0.46***	0.074***	0.375***	0.069***	0.35***
		(0.013)	(0.064)	(0.012)	(0.063)	(0.012)	(0.061)	(0.011)	(0.054)	(0.006)	(0.030)
Black x quintile 3		0.072***	0.286***	0.067***	0.267***	0.067***	0.266***	0.049***	0.193***	0.045***	0.178***
		(0.012)	(0.046)	(0.012)	(0.046)	(0.012)	(0.046)	(0.010)	(0.041)	(0.006)	(0.025)
Black x quintile 4		0.068***	0.186***	0.068***	0.186***	0.068***	0.187***	0.051***	0.14***	0.045***	0.124***
		(0.019)	(0.051)	(0.019)	(0.052)	(0.019)	(0.051)	(0.018)	(0.049)	(0.012)	(0.034)
Black x quintile 5		0.067**	0.123**	0.064**	0.117**	0.066**	0.121**	0.047	0.086	0.043*	0.079*
		(0.033)	(0.061)	(0.032)	(0.059)	(0.031)	(0.058)	(0.031)	(0.057)	(0.024)	(0.045)
Observations		394,377		394,377		394,377		394,377		394,377	
Adj. R-squared		0.150		0.162		0.165		0.167		0.178	

Notes: The above table presents coefficients and standard errors (in parentheses) underlying Figure 4. The estimates come from regressions of an indicator denoting a C-section on indicators denoting each risk quintile and interactions between these risk quintiles indicators and an indicator denoting whether the mother is Black. Only unscheduled births are included in these regressions. Controls for continuous C-section risk; time fixed effects (year-month and day-of-week fixed effects); markers of the mother's socioeconomic status ("SES") including education, martial status, and an indicator for Medicaid coverage; and hospital fixed effects are progressively added to the specification. The relative effect for Black mothers (shown above and plotted in Figure 4) is calculated by dividing the estimated coefficient on Black by the relevant mean among non-Hispanic white mothers. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017. *** denotes p-values $<$ 0.01, ** denotes p-values $<$ 0.05, * denotes p-values $<$ 0.10.

Table A9: Estimates underlying Figure 6

	Coefficient (1)	Standard error (SE) (2)	White mean (3)	Relative effect of Black (4)	SE of relative effect (5)
Risk quintile 1	0.061*	(0.035)	0.048		
Risk quintile 2	0.085**	(0.035)	0.207		
Risk quintile 3	0.105***	(0.033)	0.265		
Risk quintile 4	0.084***	(0.029)	0.376		
Risk quintile 5			0.553		
Black x quintile 1	0.032***	(0.008)		0.679***	(0.175)
Black x quintile 2	0.072***	(0.007)		0.346***	(0.032)
Black x quintile 3	0.047***	(0.007)		0.177***	(0.026)
Black x quintile 4	0.047***	(0.013)		0.124***	(0.034)
Black x quintile 5	0.041*	(0.024)		0.074*	(0.044)
Scheduled CS x quintile 1	-0.035***	(0.005)	0.016		
Scheduled CS x quintile 2	-0.126***	(0.012)	0.087		
Scheduled CS x quintile 3	-0.150***	(0.013)	0.121		
Scheduled CS x quintile 4	-0.175***	(0.026)	0.205		
Scheduled CS x quintile 5	-0.163***	(0.030)	0.389		
Scheduled CS x Black x quintile 1	-0.044***	(0.009)		-0.699	(0.848)
Scheduled CS x Black x quintile 2	-0.052***	(0.017)		0.228	(0.149)
Scheduled CS x Black x quintile 3	-0.032**	(0.016)		0.124	(0.102)
Scheduled CS x Black x quintile 4	-0.024	(0.027)		0.112	(0.125)
Scheduled CS x Black x quintile 5	0.005	(0.035)		0.118	(0.104)
Observations	394,377				
Adjusted R-squared	0.184				

Notes: The above table presents coefficients and standard errors (in parentheses) underlying Figure 6. The estimates come from estimation of an analogue of equation (3). Only unscheduled births are included, and the outcome is an indicator for whether the mother had an unscheduled C-section. The regression includes year-month, day-of-week, and hospital fixed effects and controls for maternal C-section risk and SES. "Scheduled CS" is an indicator denoting whether there was at least one scheduled C-section at the hour of the unscheduled delivery in the same hospital. Standard errors are clustered by hospital. The relative effect for Black mothers (shown above and plotted in Figure 6) is calculated by dividing the estimated coefficient on Black by the relevant mean among non-Hispanic white mothers. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017. *** denotes p-values < 0.01, ** denotes p-values < 0.05, * denotes p-values < 0.10.

Table A10: Relationship between scheduled C-sections and probability of unscheduled C-sections

a. Scheduled C-sections in hours leading up to birth

	Unscheduled C-section					
	(1)	(2)	(3)	(4)	(5)	(6)
Scheduled CS t	-0.095***					-0.098***
	(0.008)					(0.009)
Scheduled CS $t-1$		-0.039***				-0.040***
		(0.006)				(0.006)
Scheduled CS $t-2$			0.016***			0.026***
			(0.005)			(0.005)
Scheduled CS $t-3$				-0.002		0.008**
				(0.003)		(0.003)
Scheduled CS $t-4$					-0.001	0.002
					(0.003)	(0.003)
Observations	394,374	394,363	394,361	394,355	394,352	394,352
Adjusted R-squared	0.177	0.174	0.173	0.173	0.173	0.179
Mean outcome	0.181	0.181	0.181	0.181	0.181	0.181
Relative effect	-0.524***	-0.216***	0.088***	-0.012	-0.003	-0.544***
	(0.045)	(0.031)	(0.027)	(0.015)	(0.016)	(0.048)

b. Scheduled C-sections in hours following birth

	Unscheduled C-section					
	(1)	(2)	(3)	(4)	(5)	(6)
Scheduled CS t	-0.095***					-0.099***
	(0.008)					(0.009)
Scheduled CS $t+1$		-0.049***				-0.049***
		(0.007)				(0.008)
Scheduled CS $t+2$			0.020***			0.031***
			(0.007)			(0.006)
Scheduled CS $t+3$				0.000		0.012**
				(0.005)		(0.005)
Scheduled CS $t+4$					-0.008**	-0.004
					(0.003)	(0.004)
Observations	394,374	394,368	394,366	394,365	394,365	394,365
Adjusted R-squared	0.177	0.174	0.173	0.173	0.173	0.179
Mean outcome	0.181	0.181	0.181	0.181	0.181	0.181
Relative effect	-0.524***	-0.270***	0.110***	0.000	-0.043**	-0.545***
	(0.045)	(0.038)	(0.038)	(0.025)	(0.018)	(0.049)

Notes: The above table presents coefficients and standard errors (in parentheses) from estimation of an analogue of equation (1) that includes a control for whether there was a scheduled C-section in the hours surrounding the delivery in place of an indicator denoting whether the mother was Black. Only unscheduled births are included, and the outcome is an indicator for whether the mother had an unscheduled C-section. The regression includes year-month, day-of-week, and hospital fixed effects and controls for maternal C-section risk and SES. Standard errors are clustered by hospital. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2017. *** denotes p-values < 0.01, ** denotes p-values < 0.05, * denotes p-values < 0.10.

Table A11: Relationship between scheduled and unscheduled C-section shares

	Unscheduled C-section share		
Unit of observation:	Hospital-day-hour (1)	Hospital-day (2)	Hospital-week (3)
Scheduled C-section share	-0.178***	-0.164***	-0.174***
	(0.001)	(0.002)	(0.004)
Observations	860,255	175,493	27,455
Adjusted R-squared	0.065	0.065	0.152
Mean outcome	0.170	0.156	0.115

Notes: The above table presents coefficients and standard errors (in parentheses) from regressions of the share of all births (scheduled and unscheduled) delivered by unscheduled C-section on the share of all births delivered by scheduled C-section. The regressions include hospital fixed effects, and standard errors are clustered by hospital. In column (1), the unit of observation is the hospital-day-hour (e.g., births on January 1, 2008 between 9:00am and 9:59am in Hospital A); in columns (2) and (3), the unit of observation is the hospital-day and the hospital-week, respectively. Over the sample period (2008–2017), the 68 hospitals operating in New Jersey delivered babies on average during five hours per day, on five days per week, and in 43 weeks per year. Data come from the New Jersey Electronic Birth Records. *** denotes p-values < 0.01, ** denotes p-values < 0.05, * denotes p-values < 0.10.

Table A12: Effects of concurrent, scheduled C-sections on maternal health (reduced form)

a. White mothers		Individual maternal postpartum complications					
	Any (1)	Infection (2)	Pyrexia (3)	Venous (4)	Embolism (5)	Hemorrhage (6)	Other (7)
SCS x quintile 1-3	-0.005**	-0.001	-0.000	0.000	-0.000	-0.001	-0.003***
	(0.002)	(0.000)	(0.001)	(0.002)	(0.000)	(0.001)	(0.001)
SCS x quintile 4-5	0.004	-0.000	0.001	0.005	-0.001***	0.002	-0.005
	(0.005)	(0.002)	(0.002)	(0.003)	(0.000)	(0.005)	(0.004)
Observations	200,691	200,691	200,691	200,691	200,691	200,691	200,691
Adjusted R-squared	0.009	0.002	0.003	0.009	0.000	0.006	0.007
Mean outcome without scheduled C-section							
Quintile 1-3	0.055	0.003	0.003	0.011	0.000	0.023	0.020
Quintile 4-5	0.079	0.006	0.006	0.009	0.001	0.037	0.032
Relative effect of scheduled C-section							
Quintile 1-3	-0.093**	-0.233	-0.108	0.01	-0.641	-0.055	-0.166***
	(0.044)	(0.119)	(0.238)	(0.139)	(0.337)	(0.038)	(0.054)
Quintile 4-5	0.045	-0.081	0.259	0.523	-0.949***	0.055	-0.169
	(0.060)	(0.355)	(0.354)	(0.285)	(0.282)	(0.125)	(0.125)

b. Black mothers		Individual maternal postpartum complications					
	Any (1)	Infection (2)	Pyrexia (3)	Venous (4)	Embolism (5)	Hemorrhage (6)	Other (7)
SCS x quintile 1-3	-0.000	-0.001	-0.001	0.001	0.000	0.004	-0.005**
	(0.004)	(0.001)	(0.001)	(0.001)	(0.000)	(0.003)	(0.002)
SCS x quintile 4-5	-0.014	-0.006	-0.000	-0.003	0.000	-0.005	-0.004
	(0.013)	(0.003)	(0.005)	(0.002)	(0.001)	(0.008)	(0.008)
Observations	83,202	83,202	83,202	83,202	83,202	83,202	83,202
Adjusted R-squared	0.013	0.010	0.003	0.003	0.001	0.008	0.008
Mean outcome without scheduled C-section							
Quintile 1-3	0.066	0.008	0.006	0.006	0.000	0.027	0.028
Quintile 4-5	0.104	0.014	0.009	0.006	0.001	0.042	0.048
Relative effect of scheduled C-section							
Quintile 1-3	-0.005	-0.14	-0.181	0.123	0.683	0.155	-0.179**
	(0.059)	(0.151)	(0.148)	(0.181)	(0.986)	(0.100)	(0.072)
Quintile 4-5	-0.132	-0.454	-0.055	-0.444	0.168	-0.11	-0.088
	(0.130)	(0.229)	(0.608)	(0.366)	(0.847)	(0.180)	(0.165)

Notes: The above table presents coefficients and standard errors (in parentheses) from estimation of equation (5). "SCS" denotes whether the birth occured at the same time as a scheduled C-section. Only unscheduled births among white mothers (panel (a)) and Black mothers (panel (b)) are included. In columns (2)–(7), the outcome is an indicator for whether the mother experienced each of the following complications in the 90 days following delivery (ICD-9 in parentheses), respectively: major puerperal infection (670), pyrexia (672), venous complications (671), pulmonary embolism (673), postpartum hemorrhage (666), and other postpartum complications (674). The outcome in column (1) is an indicator denoting whether the mother experienced any of the aforementioned conditions. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2015. *** denotes p-values < 0.01, ** denotes p-values < 0.05, * denotes p-values < 0.10.

Table A13: Effects of unscheduled C-sections on maternal health (2SLS)

a. White mothers		Individual maternal postpartum complications					
	Any	Infection	Pyrexia	Venous	Embolism	Hemorrhage	Other
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
UCS x quintile 1-3	0.069**	0.008	0.005	0.000	0.002	0.017	0.040***
	(0.034)	(0.004)	(0.010)	(0.020)	(0.001)	(0.012)	(0.013)
UCS x quintile 4-5	-0.021	0.003	-0.009	-0.030	0.004***	-0.012	0.033
	(0.028)	(0.012)	(0.013)	(0.019)	(0.001)	(0.026)	(0.023)
Observations	200,691	200,691	200,691	200,691	200,691	200,691	200,691
Adjusted R-squared	0.006	0.003	0.002	0.008	-0.002	0.005	0.008
Mean outcome with unscheduled vaginal delivery							
Quintile 1-3	0.051	0.002	0.002	0.012	0.000	0.023	0.016
Quintile 4-5	0.080	0.004	0.004	0.014	0.001	0.046	0.023
Relative effect of unscheduled C-section							
Quintile 1-3	1.344**	4.278	2.391	0.039	9.868	0.761	2.521***
	(0.658)	(2.316)	(4.589)	(1.657)	(5.894)	(0.514)	(0.839)
Quintile 4-5	-0.266	0.789	-2.249	-2.116	7.2***	-0.269	1.455
	(0.345)	(3.410)	(3.125)	(1.327)	(1.948)	(0.573)	(0.993)

b. Black mothers		Individual maternal postpartum complications					
	Any	Infection	Pyrexia	Venous	Embolism	Hemorrhage	Other
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
UCS x quintile 1-3	-0.0001	0.008	0.010	-0.007	-0.003	-0.039	0.045***
	(0.036)	(0.010)	(0.008)	(0.010)	(0.004)	(0.028)	(0.017)
UCS x quintile 4-5	0.079	0.038	0.003	0.016	-0.001	0.026	0.025
	(0.084)	(0.022)	(0.030)	(0.015)	(0.007)	(0.046)	(0.046)
Observations	83,202	83,202	83,202	83,202	83,202	83,202	83,202
Adjusted R-squared	0.011	0.011	0.006	-0.000	-0.001	0.001	0.011
Mean outcome with unscheduled vaginal delivery							
Quintile 1-3	0.058	0.005	0.004	0.006	0.000	0.028	0.023
Quintile 4-5	0.091	0.007	0.003	0.009	0.001	0.052	0.030
Relative effect of unscheduled C-section							
Quintile 1-3	-0.006	1.803	2.707	-1.164	-6.188	-1.398	1.987***
	(0.614)	(2.173)	(2.300)	(1.599)	(9.207)	(1.001)	(0.767)
Quintile 4-5	0.863	5.277	0.826	1.809	-1.852	0.502	0.819
	(0.924)	(3.155)	(8.680)	(1.621)	(9.176)	(0.879)	(1.520)

Notes: The above table presents coefficients and standard errors (in parentheses) from estimation of a two-stage least squares analogue of equation (5). We instrument for whether the mother had an unscheduled C-section (UCS) using an indicator denoting whether the birth occured at the same time as a scheduled C-section; the Kleibergen-Paap F-statistic is 30.29 and 28.76 in panels (a) and (b), respectively. Only unscheduled births among white mothers (panel (a)) and Black mothers (panel (b)) are included. In columns (2)–(7), the outcome is an indicator for whether the mother experienced each of the following complications in the 90 days following delivery (ICD-9 in parentheses), respectively: major puerperal infection (670), pyrexia (672), venous complications (671), pulmonary embolism (673), postpartum hemorrhage (666), and other postpartum complications (674). The outcome in column (1) is an indicator denoting whether the mother experienced any of the aforementioned conditions. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2015. *** denotes p-values < 0.01, ** denotes p-values < 0.05, * denotes p-values < 0.10.

Table A14: Effects of concurrent, scheduled C-sections on infant health (reduced form)

a. Infants born to white mothers		Individual infant health complications			
	Any (1)	NICU admission (2)	Low Apgar score (3)	Mechanical ventilation (4)	Significant birth injury (5)
SCS x quintile 1-3	-0.009**	-0.010**	-0.000	-0.003	0.001
	(0.004)	(0.004)	(0.000)	(0.002)	(0.001)
SCS x quintile 4-5	0.016**	0.016**	0.004	0.004	-0.000
	(0.007)	(0.007)	(0.003)	(0.004)	(0.000)
Observations	200,691	200,691	200,691	200,691	200,480
Adjusted R-squared	0.106	0.109	0.012	0.038	0.042
Mean outcome without scheduled C-section					
Quintile 1-3	0.057	0.051	0.004	0.007	0.002
Quintile 4-5	0.132	0.122	0.011	0.024	0.003
Relative effect of scheduled C-section					
Quintile 1-3	-0.166***	-0.191**	-0.119	-0.477	0.250
	(0.066)	(0.079)	(0.114)	(0.259)	(0.221)
Quintile 4-5	0.122**	0.129**	0.382	0.171	-0.089
	(0.053)	(0.056)	(0.270)	(0.167)	(0.092)

b. Infants born to Black mothers		Individual infant health complications			
	Any (1)	NICU admission (2)	Low Apgar score (3)	Mechanical ventilation (4)	Significant birth injury (5)
SCS x quintile 1-3	-0.012***	-0.013***	0.001	-0.003	-0.000
	(0.004)	(0.004)	(0.002)	(0.002)	(0.000)
SCS x quintile 4-5	-0.007	-0.003	-0.011	0.006	-0.001
	(0.016)	(0.015)	(0.006)	(0.007)	(0.000)
Observations	83,202	83,202	83,202	83,202	83,080
Adjusted R-squared	0.106	0.109	0.026	0.038	0.010
Mean outcome without scheduled C-section					
Quintile 1-3	0.095	0.089	0.012	0.014	0.001
Quintile 4-5	0.213	0.194	0.036	0.046	0.001
Relative effect of scheduled C-section					
Quintile 1-3	-0.130***	-0.142***	0.087	-0.179	-0.067
	(0.047)	(0.046)	(0.186)	(0.169)	(0.392)
Quintile 4-5	-0.035	-0.013	-0.293	0.126	-0.494
	(0.073)	(0.080)	(0.173)	(0.146)	(0.253)

Notes: The above table presents coefficients and standard errors (in parentheses) from estimation of equation (5). "SCS" denotes whether the birth occured at the same time as a scheduled C-section. Only unscheduled births among white mothers (panel (a)) and Black mothers (panel (b)) are included. In columns (2)–(5), the dependent variable is an indicator for whether the infant experienced each of the following complications, respectively: admission to the NICU, 5-minute Apgar score below 7, mechanical ventilation needed, and significant birth injury. The outcome in column (1) is an indicator denoting whether the infant experienced any of the aforementioned conditions. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2015. *** denotes p-values < 0.01, ** denotes p-values < 0.05, * denotes p-values < 0.10.

Table A15: Effects of unscheduled C-sections on infant health (2SLS)

a. Infants born to white mothers		Individual infant health complications			
	Any	NICU admission	Low Apgar score	Mechanical ventilation	Significant birth injury
	(1)	(2)	(3)	(4)	(5)
UCS x quintile 1-3	0.130**	0.134**	0.008	0.045	-0.008
	(0.056)	(0.060)	(0.006)	(0.025)	(0.007)
UCS x quintile 4-5	-0.098***	-0.096**	-0.026	-0.024	0.002
	(0.038)	(0.040)	(0.017)	(0.022)	(0.002)
Observations	200,691	200,691	200,691	200,691	200,480
Adjusted R-squared	0.084	0.083	0.008	0.020	0.040
Mean outcome with unscheduled vaginal delivery					
Quintile 1-3	0.053	0.047	0.003	0.006	0.003
Quintile 4-5	0.122	0.109	0.013	0.019	0.004
Relative effect of unscheduled C-section					
Quintile 1-3	2.460**	2.826**	2.270	7.448	-3.047
	(1.067)	(1.266)	(1.643)	(4.150)	(2.682)
Quintile 4-5	-0.805***	-0.880**	-1.986	-1.264	0.439
	(0.311)	(0.367)	(1.271)	(1.161)	(0.463)

b. Infants born to Black mothers		Individual infant health complications			
	Any	NICU admission	Low Apgar score	Mechanical ventilation	Significant birth injury
	(1)	(2)	(3)	(4)	(5)
UCS x quintile 1-3	0.111**	0.114***	-0.012	0.025	0.000
	(0.045)	(0.042)	(0.018)	(0.025)	(0.002)
UCS x quintile 4-5	0.044	0.016	0.061	-0.034	0.003
	(0.089)	(0.088)	(0.038)	(0.040)	(0.002)
Observations	83,202	83,202	83,202	83,202	83,080
Adjusted R-squared	0.101	0.104	0.009	0.033	0.009
Mean outcome with unscheduled vaginal delivery					
Quintile 1-3	0.088	0.082	0.011	0.014	0.001
Quintile 4-5	0.195	0.169	0.044	0.042	0.002
Relative effect of unscheduled C-section					
Quintile 1-3	1.262**	1.398***	-1.070	1.845	0.349
	(0.511)	(0.517)	(1.599)	(1.807)	(3.209)
Quintile 4-5	0.226	0.095	1.375	-0.794	1.903
	(0.459)	(0.519)	(0.857)	(0.938)	(0.985)

Notes: The above table presents coefficients and standard errors (in parentheses) from estimation of a two-stage least squares analogue of equation (5). We instrument for whether the mother had an unscheduled C-section (UCS) using an indicator denoting whether the birth occured at the same time as a scheduled C-section; the Kleibergen-Paap F-statistic is 30.29 and 28.76 in panels (a) and (b), respectively. Only unscheduled births among white mothers (panel (a)) and Black mothers (panel (b)) are included. In columns (2)–(5), the dependent variable is an indicator for whether the infant experienced each of the following complications, respectively: admission to the NICU, 5-minute Apgar score below 7, mechanical ventilation needed, and significant birth injury. The outcome in column (1) is an indicator denoting whether the infant experienced any of the aforementioned conditions. Data come from the New Jersey Electronic Birth Records and cover the period 2008 to 2015. *** denotes p-values < 0.01, ** denotes p-values < 0.05, * denotes p-values < 0.10.

C Conceptual framework

This section introduces a simple framework for thinking about a physician's decision to perform a C-section. The framework captures the factors that could lead to the racial differences in C-section rates outlined in Section II and shows how changes in the racial gap in the presence of capacity constraints can help differentiate between potential drivers of observed treatment disparities.

Set-up Suppose that patients are ordered by their appropriateness for a C-section, A. For a given patient, the doctor chooses whether to perform a C-section or a vaginal delivery. We assume that providers care about the health impacts they have on patients, and thus they are interested in providing the delivery method that yields the highest health benefit for the patient and their offspring. That is, if $A > A'$, then the physician derives higher utility from performing a C-section on a patient with appropriateness A than a patient with appropriateness A'. In addition to caring about their impacts on patient health, doctors also care about the effort that they need to exert (e) and the payment that they receive for providing a given service (f).

The utility that a physician receives from performing a C-section (U_c) or a vaginal delivery (U_v) can be denoted as follows:

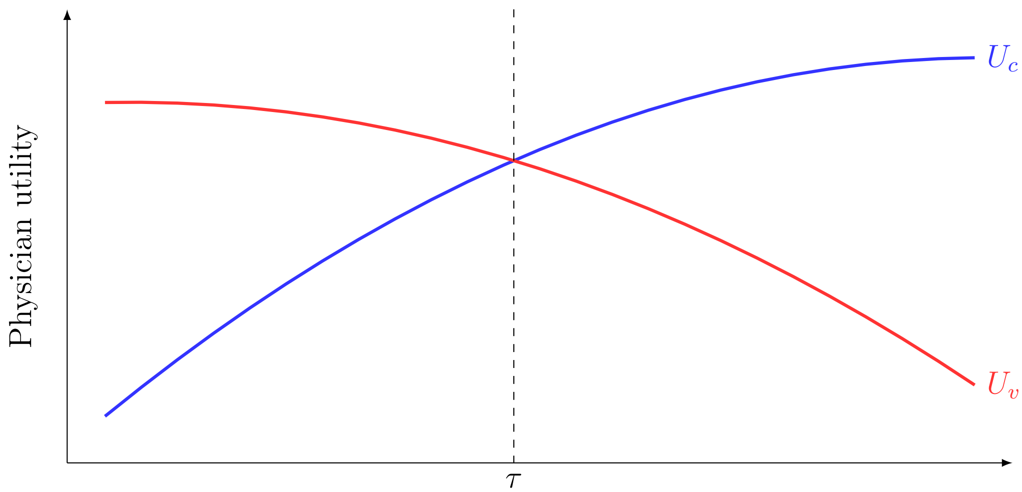
$$U_c = g\left(A, e_c, f_c\right) \quad \text{where } g_A > 0,\ g_{e_c} < 0,\ g_{f_c} > 0$$
$$U_v = h\left(A, e_v, f_v\right) \quad \text{where } h_A < 0,\ h_{e_v} < 0,\ h_{f_v} > 0$$

Since $g_A > 0$ and $h_A < 0$, the two curves cross. The crossing point yields a threshold level of A, denoted by τ, which determines whether a C-section is performed. As shown in Figure A5(a), the doctor derives less (more) utility from doing a C-section to the left (right) of τ, and thus C-sections are only performed on mothers with $\tau \leq A$.

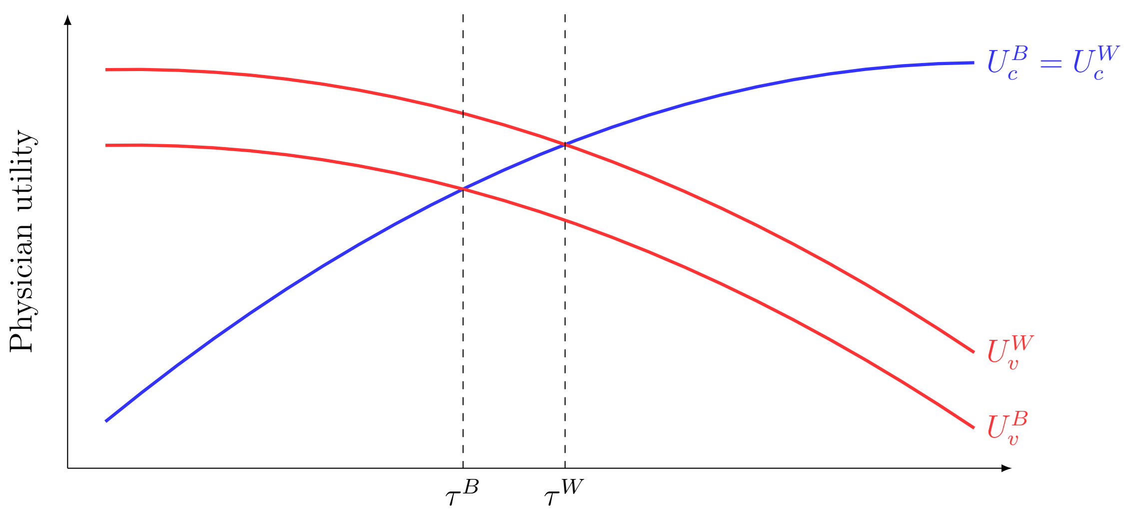
If there is a racial dimension to the doctor's choices, this can be depicted by assuming that the doctor's utility differs depending on whether they are treating a Black patient (U^B) or a white patient (U^W). Figure A5(b) depicts a case in which the doctor's utility from providing a vaginal delivery for a Black patient is less than the doctor's utility from providing a vaginal

Figure A5: Physician utility from C-section versus vaginal delivery

(a) Baseline model



(b) Heterogeneity by maternal race



Notes: The above figure shows the utility that a physician receives from performing a C-section (U_c) or vaginal birth (U_v) as a function of patient appropriateness for a C-section (A). Since the utility from performing a C-section (vaginal birth) is increasing (decreasing) in patient appropriateness, the two curves cross. The crossing yields a threshold level of appropriateness τ above (below) which the doctor performs a C-section (vaginal birth). Subfigure (a) presents the case in which there is no racial dimension to the doctor's choice. Subfigure (b) instead presents a case in which doctors have lower utility from performing a vaginal birth on Black mothers relative to white mothers. This difference in utility leads doctors to set a lower threshold for Black mothers ($\tau^B < \tau^W$) and perform additional C-sections on Black mothers who are less appropriate for the surgery.

delivery to a white patient with the same appropriateness for a C-section.[29] If doctors find that it requires more effort to communicate and monitor Black patients (i.e., $e_v^B > e_v^W$), then this could result in a lower utility curve.As shown in Figure A5(b), more low-risk Black mothers will receive C-sections than low-risk white mothers if U_v^B lies below U_v^W. However, since all high-risk mothers receive C-sections, there is no racial gap for the patients who are most appropriate for the procedure.

Changes in capacity We now consider the impacts of capacity constraints on the racial gap in C-sections across the risk spectrum. If it is obvious that a patient does not need a C-section, then it will be more costly for a doctor to procure the hospital resources necessary to perform one when the obstetrical unit is more constrained. The doctor's utility from performing an unnecessary, unscheduled C-section is therefore reduced when there is a scheduled C-section in progress. In contrast, if a patient truly needs an emergency C-section, then the doctor will gain a lot of utility from performing one even if the hospital is busy. For a true medical emergency, other hospital resources—such as other locations for the surgery—can be pressed into service.

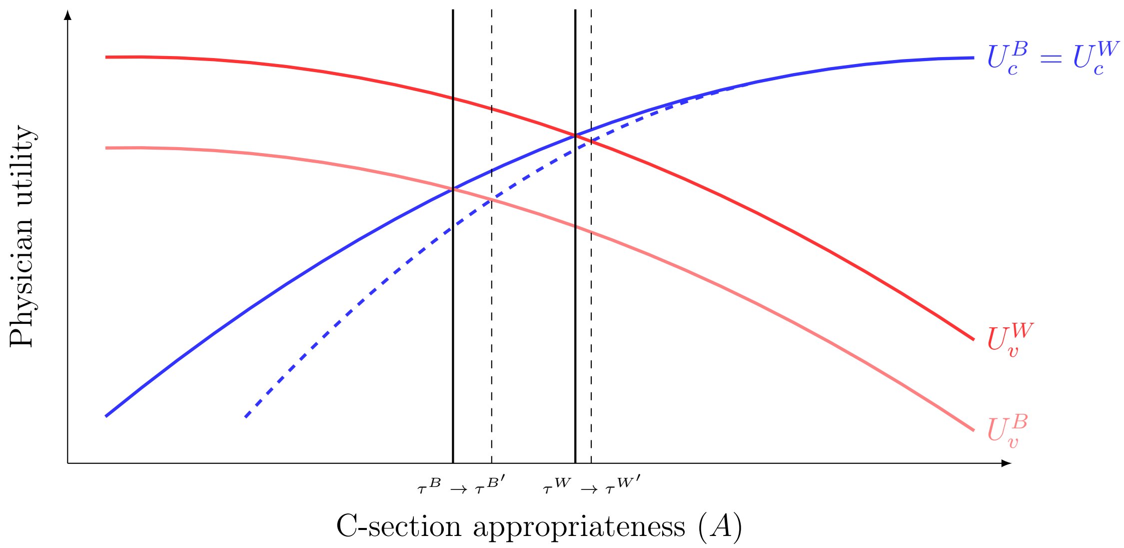
Changes in C-section rates in the presence of reduced capacity can be used to shed light on the drivers of observed racial differences in C-section rates. Suppose first that the observed racial gap in C-section rates is driven by doctors setting a lower threshold for Black patients than for white patients (as in Figure A5(b)). As shown in Figure A6(a), reductions in the utility that physicians receive from doing C-sections on lower risk mothers when there is a concurrent, scheduled C-section leads physicians to set higher thresholds for both Black and white patients. However, because marginal Black mothers are less in need of C-sections, the threshold rises more for Black patients than for white patients. Hence, if the racial gap is driven by providers setting a lower threshold for Black patients, then the racial gap in C-section rates should narrow when there is a concurrent, scheduled C-section.

Now suppose that doctors treat Black and white patients equally (as in Figure A5(a)).

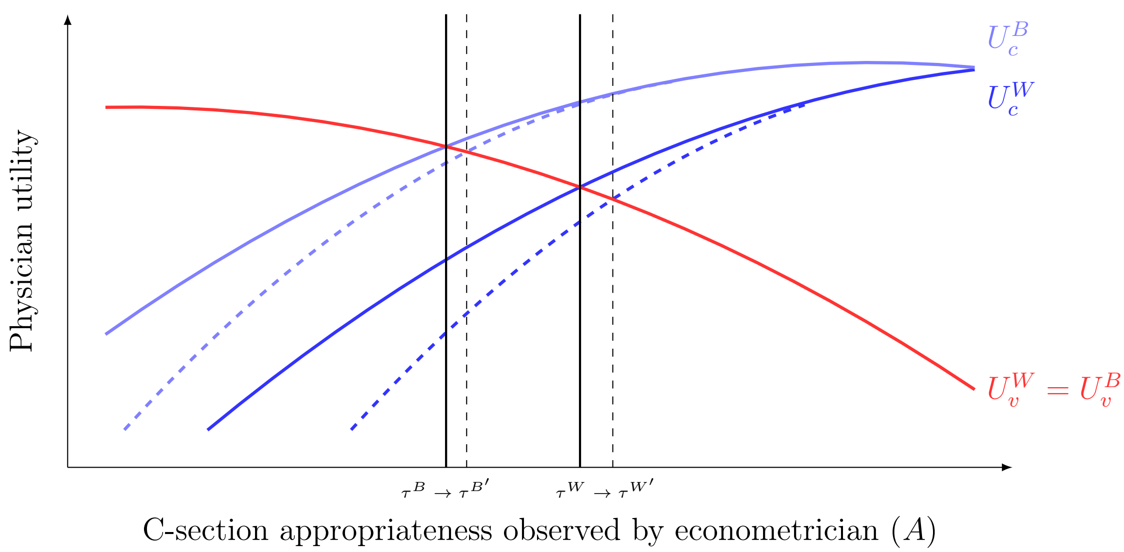
[29]Figure A5(b) depicts the physician's utility of performing a C-section as being the same for Black and white mothers (i.e., $U_c^B = U_c^W$). This might be the case if, for example, the doctor is biased but interaction with the patient is minimized in a C-section compared to a vaginal delivery. However, it is not necessary that the curves be identical to generate $\tau^B < \tau^W$. Rather, it is only necessary that the vertical distance between the U_c^B and U_c^W curves is less than the vertical distance between the U_v^B and U_v^W curves.

Figure A6: Physician utility by delivery method with reduced capacity

(a) Differences in provider discretion



(b) Differences in unobserved health risk



Notes: The above figures show how the optimal thresholds set by physicians change in the presence of reduced capacity. Subfigure (a) presents the case in which doctors set different thresholds for Black and white patients at baseline. When the capacity for C-sections declines, physician utility from performing C-sections on lower risk mothers is reduced (dashed line). This leads doctors to set higher thresholds for mothers of both races, with the change in optimal threshold being higher for Black mothers. Hence, the racial gap falls in the presence of reduced capacity. Subfigure (b) presents the case in which Black mothers are more appropriate for C-sections than is observed by the econometrician, leading to the (false) appearance of different thresholds by race. Doctors again set higher thresholds in the presence of reduced capacity, but, since Black mothers are more appropriate conditional on observed risk, the change in the observed threshold for white mothers is greater than for Black mothers. Hence, the racial gap rises in the presence of reduced capacity.

For researchers to observe a difference in C-section rates conditional on observed risk, it must be the case that Black mothers are unobservably (to the econometrician) riskier than their white counterparts. Suppose that doctors observe a patient's true risk for a C-section, $\tilde{A}$. As shown in Figure A6(b), if $\tilde{A}_B > A_B$ and $\tilde{A}_W = A_W$, then it will appear to the econometrician that doctor's are setting a lower threshold for Black mothers ($\tau_B < \tau_W$) when in fact the true threshold is the same ($\tilde{\tau}_B = \tilde{\tau}_W = \tilde{\tau}$). In this case, the presence of reduced capacity will lead physicians to raise the true threshold for mothers of both races equally. However, because marginal white mothers are less in need of C-sections conditional on observed risk, the observed threshold will be raised more for White mothers. Hence, if the racial gap is driven by higher unobserved risk among Black patients, then the racial gap in C-section rates should grow when there is a concurrent, scheduled C-section.[30]

[30] The gap will grow both if Black mothers truly have higher risk than the econometrician observes or if doctors simply perceive Black mothers' risk to be higher. That is, if doctors believe that there is a higher risk of negative outcomes among Black mothers, then they should reduce unscheduled C-sections among white mothers first when the costs of unscheduled C-sections rise, regardless of whether their beliefs about higher risk among Black mothers are true.