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ABSTRACT

Small-area-variation studies have shown that physician treatment styles differ substantially both between and within markets, controlling for patient characteristics. Using a data set containing the universe of deliveries in Florida over a 12-year period with consistent physician identifiers and a rich set of patient characteristics, we examine why treatment styles differ across obstetricians at a point in time, and why styles change over time. We find that the variation in c-section rates across physicians within a market is two to three times greater than the variation between markets. Surprisingly, residency programs explain less than four percent of the variation between physicians in their risk-adjusted c-section rates, even among newly-trained physicians. Although we find evidence that physicians, especially relatively inexperienced ones, learn from their peers, they do not substantially revise their prior beliefs regarding how patients should be treated due to the local exchange of information. Our results indicate that physicians are not likely to converge over time to a community standard; thus, within-market variation in treatment styles is likely to persist.

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1. Introduction

There is an extensive literature demonstrating that people in the United States receive a substantially different amount and type of medical care depending on where they live (e.g., Wennberg and Gittelsohn, 1973; Wennberg, Freeman, and Culp, 1987; Wennberg, Fisher, and Skinner, 2002). These studies usually compare the use rate of a particular treatment (e.g., back surgeries per capita) or medical expenditures across cities, counties, or states. If there is a single treatment method that patients prefer, there will be welfare losses when the use rate diverges from the medically appropriate standard.[1] Phelps and Parente (1990) estimated an annual welfare loss in 1987 due to variations in hospital use rates of $33 billion.

What matters to a consumer is whether the physician she chooses provides the appropriate treatment, not whether physicians in her market provide the appropriate treatment on average. As Phelps and Parente (1990) point out, their $33 billion estimate will understate the true welfare loss if there is variation in use rates *within* a market (e.g., variation across physicians in their likelihood of admitting patients to a hospital) as well as between markets. That is, even if the mean use rate of a market conforms to best medical practices, there will still be patients receiving too much or too little of the treatment if physicians in that market treat patients quite differently.

A less frequently cited set of studies show that there is indeed considerable variation across physicians within a market in how they treat patients, controlling for patients' observed health. Stano and Folland (1988), for example, report that variation in the amount of medical

[1] Use rates could vary across regions due to differences in prices, income, patients' health status, patients' preferences, or physicians' ability or willingness to induce demand for their services. Phelps (2000) concludes that these factors collectively explain very little of the differences in the amount of medical care received. Several other authors concur with this assessment, including Chassin et al. (1986), Bikhchandani *et al.* (2001), and Newhouse (2002).

care patients receive, measured by relative value units (RVUs),[2] is three to four times larger across physicians within a market as across markets. Other studies find substantial variation across physicians in cesarean-section rates (Grant and McInnes, 2004; Goyert *et al*., 1989), RVUs per hospital admission (Welch, Miller, and Welch, 1994), hospitalization rates, hospital days, and length of hospital stays (Roos *et al*., 1986), total medical expenditures (Phelps, 2000), and medical expenditures on outpatient care (Grytten and Sorensen, 2003). These results indicate that economists may be underestimating the welfare losses associated with variations in treatment styles, and the value to consumers of information on providers' treatment styles.[3]

One concern with the latter set of studies, however, is that within-market variations will be overstated if patients' unmeasured health differs across practices due to physician specialization or if the number of patients per physician is small and treatment styles are measured with error (Hofer *et al*., 1999). Grant and McInnes (2004) and Roos *et al.* (1986) have detailed health information, but the other studies cited above use no or few risk adjusters. Welch, Miller, and Welch (1994) and Roos *et al.* (1986) analyze all physicians with 10 or more and 15 or more admissions per year, respectively, which raises concerns about measurement error. In a sample where each physician treated an average of 16 diabetic patients, Hofer *et al.* (1999) find that at least 96 percent of the variation across physicians in hospitalization and outpatient visit rates is due to unmeasured patient factors or chance, rather than physician practice styles.

The first objective of this paper is to measure the amount of variation in treatment styles between obstetricians practicing in the same market. Our primary measure of treatment style is the proportion of a physician's deliveries performed by cesarean section, but we also examine elective c-section rates and c-section rates conditional on a woman going into labor. We use

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[2] Relative value units are a way to aggregate heterogeneous services into a single measure. Folland and Stano (1988) assigned a routine office visit a value of one, and every other service a value proportional to its charge relative to a routine office visit.

[3] If patients have preferences for different treatment styles and choose physicians accordingly, then some component of the within-market variation will enhance welfare. Epstein, Ketcham, and Nicholson (2005)

detailed information from hospital discharge abstracts to adjust a physician's treatment style for patients' health, a potentially important source of variation. Moreover, the analysis is restricted to physicians who delivered 50 or more babies per year in order to measure treatment styles precisely.

The choice of delivery method has implications for physicians, patients and payers. With over 900,000 cesarean sections performed annually in the United States, c-sections are the second most common surgical procedure. Women who received a c-section in Florida between 1992 and 2003 remained in the hospital 3.6 days, on average, versus 2.1 days for women who had vaginal deliveries. The average hospital charge for a c-section in Florida in the 1990s was $8,500, almost twice the charge for a vaginal delivery, while the average physician charge for a c-section is about $500 higher than for a vaginal delivery (Gruber, Kim, and Mayzlin, 1999).

Our second objective is to examine the source and importance of physician learning. Specifically, we address whether residency programs exert a strong influence on physicians' treatment styles, whether physicians learn from their immediate colleagues once they begin practicing, and whether learning leads to substantial changes in treatment styles over time. Phelps and Mooney (1993) propose a theoretical model to explain why treatment rates vary across markets and why a physician's treatment style may change as he gains experience. They argue that physicians form beliefs about the appropriateness and effectiveness of medical technologies during medical school and residency training. When a physician begins practicing medicine, he observes how his colleagues treat patients and updates his prior belief about the appropriateness of a technology or treatment method. The treatment styles of a physician's peer group, therefore, serve as an inexpensive source of clinical information for continuing education. Phelps and Mooney theorize that physicians' treatment styles will converge over time to a single community standard, but standards will differ across markets because residency programs

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find that one-third of the within-market variation in cesarean section rates is due to patient-physician matching based on preferences.

produce physicians with different beliefs, and graduates of residency programs locate unevenly across markets.[4] In the long run, therefore, this model predicts there will be inter-market variation in practice patterns but little intra-market variation across physicians.

There have been few empirical tests of the Phelps and Mooney (1993) model, or even components of the model. Roos *et al.* (1986) find that younger primary care physicians, physicians with a relatively small patient panel, and those trained in Manitoba are slightly more likely to hospitalize patients relative to other physicians practicing in Canada. Grant and McInnes (2004) find that obstetricians who experience a large financial malpractice claim subsequently perform more c-sections and obstetricians who experience a small claim perform fewer c-sections, which indicate that physicians adjust their treatment styles as they learn from their interactions with the legal system. The former study uses a cross-sectional data set and the latter study uses a two-year panel.

Our data set contains the universe of hospital admissions in Florida over a 12-year period, and includes consistent physician identifiers and characteristics, such as information on where physicians trained. We test whether residency programs produce physicians with distinct treatment styles, and whether those styles persist beyond the first few years of practice. If so, then residency programs would be an effective means of promoting evidence-based medicine. If a physician's gender, race, experience and residency program explain a substantial amount of the variation in treatment styles, consumers can use those characteristics to reduce their cost of searching for a physician with their desired treatment style.

The panel nature of the data allows us to explore whether a physician learns from his immediate peers, and whether learning is important relative to other market-specific forces, such as changes in reimbursement and the malpractice environment. We construct two peer group variables -- the treatment style of physicians who deliver in the same hospital(s) as physician j

[4] Banerjee (1992), Scharfstein and Stein (1990), Ellison and Fudenberg (1993, 1995), and Bikhchandani, Hirschleifer, and Welch (1992) have also presented general models where individuals observe the decisions

(the "local" peer group), and the treatment style of physicians who deliver in all other hospitals in physician j's market (the "regional" peer group). If both the local and regional peer groups are exposed to the same market policies and shocks, we can separately measure the influences of the local exchange of information and other regional factors. If policies and shocks in fact differ within a small geographic market, our local peer variable will provide an upper bound on the effect of local learning.

We find that the variation in c-section rates across physicians within a market is two to three times larger than the inter-market variation, controlling for observed patient characteristics. This implies that existing estimates of the welfare loss stemming from practice variation may be too low, and private health insurers and the government may be underestimating the value of standardizing treatment methods. Treatment styles are not strongly shaped by residency training programs and are rather impervious to market-specific shocks and changes in peer treatment styles. Residency programs explain less than four percent of the variation between physicians in c-section rates, even among physicians who have been practicing for fewer than four years. Over 30 percent of the variation in risk-adjusted c-section rates across physicians and years is due to time-invariant, physician-specific factors other than experience, gender, race, and where a physician received residency training. Because we have detailed information on the characteristics of a physician's patients, our interpretation is that a considerable amount of practice variation is due to idiosyncratic physician perceptions regarding the appropriateness of specific treatments.

Although we find evidence that physicians, especially relatively inexperienced physicians, learn from their peers, they do not substantially revise their prior beliefs regarding how patients should be treated due to the local exchange of information. A one-standard deviation increase in the risk-adjusted c-section rate of a local peer group is predicted to increase a new obstetrician's risk-adjusted c-section rate by 6.0 percent, versus 3.0 percent for an

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of their peers, update their priors, and rationally decide to herd on the choices of their peers.

obstetrician with 16 years of experience. Our results imply that physicians are not likely to converge over time to a community standard, thereby eliminating the within-market variation in treatment styles.

In the next section we present the conceptual framework for the paper and some descriptive data on c-section rates in Florida between 1992 and 2003. We describe the data and methods in Section 3; Section 4 contains our estimation results; and we conclude in Section 5.

2. Conceptual Framework

Our primary measure of a physician's treatment style is the proportion of deliveries he performs by cesarean section, controlling for patients' observed characteristics or risk. This proportion, Y, can be decomposed into the proportion of patients who go into labor (θ) multiplied by the obstetrician's c-section rate conditional on labor (Y_θ), plus the proportion of patients who do not go into labor but are instead scheduled to receive a c-section ($1-\theta$):

(1) $$Y = \theta Y_\theta + (1 - \theta)$$

For each physician we separately measure the overall c-section rate (Y), the proportion of patients receiving a c-section without laboring ($1-\theta$), and the c-section rate conditional on labor (Y_θ), and we adjust all three treatment style measures based on each patient's observed risk characteristics.

The overall, unadjusted c-section rate in Florida changed markedly during our 1992 to 2003 sample period. The c-section rate in Florida fell from 25.7 percent in 1992 to 22.8 percent in 1996, as displayed in Figure 1. During this period slightly fewer c-sections were scheduled (the percentage of deliveries where the mother went into labor is reported at the bottom of Figure 1), and the c-section rate among women who went into labor was also declining. The c-section rate has increased steadily since 1996, reaching 33.1 percent in 2003. The rise in the c-section rate was driven primarily by a doubling of the elective (or scheduled) c-section rate, from 10.9 percent in 1996 to 23.3 percent of all deliveries in 2003.

C-sections are not a new technology, so one might expect information regarding the medically appropriate use of this treatment to have diffused widely, resulting in near uniformity of the c-section rate across regions. However, as with most medical treatments, there is considerable regional variation in the proportion of deliveries performed by c-section. In Table 1 we report the mean c-section rate in the 11 Florida health districts in 2003, adjusted for patient health characteristics and health insurance status. The c-section rate ranges from 18.8 percent to 27.3 percent, and regions with a high overall c-section rate tend to have both a relatively high scheduled c-section rate and a relatively high c-section rate conditional on a woman going into labor.

Chetty (1998) develops a theoretical model of the decision to use c-section versus vaginal delivery in which some women (and/or their babies) will have better outcomes with a vaginal delivery and others with a c-section. Physicians choose a risk threshold such that women with values below this threshold receive a vaginal delivery, and women with values above this threshold receive a c-section. Because physicians estimate a woman's true risk with error, some c-sections will be performed when a vaginal delivery would have produced a better outcome, *ex post*, and vice versa with some vaginal deliveries. If physicians were perfect agents, they would choose a risk threshold such that the expected cost to the patient of a c-section when, *ex post*, a vaginal delivery would have produced a superior outcome, is equal to the expected cost of a vaginal delivery when a c-section would have produced a superior outcome.

Phelps and Mooney (1993) propose that physicians form beliefs about the appropriateness and effectiveness of medical technologies during medical school and residency training, similar to the views expressed by Wennberg and Gittelsohn (1973), Wennberg (1985), and Stano (1993). In our context, variation in the c-section within a region will occur if physicians choose different risk thresholds, controlling for observed patient characteristics, either due to information they acquired during their formal medical education or due to their idiosyncratic views. Physicians who attach a high cost to performing a vaginal delivery when a c-section was merited, *ex post*, will choose a low risk threshold and will have a high c-section rate, while physicians who attach a high cost to performing a c-section when a vaginal deliver was merited will choose a high threshold and will have a low rate.

If residency programs produce physicians with distinctive treatment styles and graduates locate unevenly across markets, then treatment styles will also vary between regions. Phelps and Mooney (1993) hypothesize that physicians will update their prior beliefs regarding the appropriateness of a technology or treatment method based on how their colleagues treat similar patients. If this form of local learning has a strong effect, physicians' treatment styles would converge over time to a single regional standard.

Over the last decade, economists have examined whether peer groups affect peoples' behavior in a wide variety of settings.[5] To the best of our knowledge, however, there has been only one empirical study of whether a physician's treatment style is influenced by the treatment style of his immediate colleagues and, if so, how important this phenomenon is relative to other factors that may influence treatment decisions. Escarce (1996) finds that once a general surgeon began performing laparoscopic cholecystectomies, it promoted early adoption among other surgeons at the same hospital. If peer effects are strong, the diffusion of a public policy that promotes a particular treatment method will accelerate as the number of physicians adopting that treatment increases. One explanation for the paucity of these studies is the difficulty of separating the causal effect of the peer group from unobserved factors, market forces, and market policies that affect both a physician and his peer group (Manski, 1993).

3. Methods and Data

[5] For example, recent studies measure the influence of peers on a teenagers' criminal behavior (Glaeser, Sacerdote, and Scheinkman, 1996), the likelihood that teenagers will complete high school and become pregnant (Evans, Oates, and Schwab, 1996), and high school students' use of cigarettes, alcohol, and drugs (Gaviria and Raphael, 2001).

3.1. Data

We construct our sample from the 1992-2003 Florida hospital discharge data sets, which contain information on 2.2 million deliveries that occurred at all non-federal, short-term acute care hospitals in Florida. We observe the mother's demographic information (age, race, ethnicity), her insurance coverage (e.g., HMO), codes for the primary diagnosis and secondary diagnoses, procedure codes that specify whether the baby was delivered vaginally or via c-section, a unique and consistent (across hospitals and years) physician identifier, a unique and consistent hospital identifier, and the quarter and year the patient was discharged. Sample means and standard deviations for the patient-level data set are reported in Table 2.

The diagnoses codes allow us to control for objective health conditions that affect the probability a physician will perform a c-section (e.g., whether a woman has had a c-section prior to this delivery, whether the fetus was malpositioned during the delivery such as in the breech position, or whether the labor occurred before the fetus was full-term).[6] We use a method developed by Henry *et al.* (1995) and Gregory *et al.* (2002) to determine whether a woman went into labor. Women who delivered vaginally or had diagnoses codes indicating fetal distress, labor abnormalities, cord prolapse, or a breech converted to vertex presentation were interpreted as having gone into labor; all other women were coded as having a scheduled c-section.

Because the data contain all hospital discharges with consistent physician identifiers, we are able to examine a physician's entire inpatient practice over time. We link the physician license numbers to data from the American Medical Association's (AMA) Masterfile to collect information on each physician's gender and race, the residency program(s) where he received training, and the year he completed residency training. We use the latter information to create a variable for years of post-residency experience. We also have information on race for a subset of physicians from the Florida State Medical Board.

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[6] Two diagnoses that are frequently associated with a c-section, fetal distress and abnormal labor, are fairly subjective, so we do not include these as control variables.

We include all physicians when constructing peer group averages, but omit from the subsequent analyses physicians who delivered fewer than 50 babies in any year in which they practiced in Florida. Omitting small-volume physicians should increase the precision of the practice style measures.

3.2 Measuring Physicians' Treatment Styles

We would like our measures of treatment style to characterize how each physician would treat the same set of patients. Absent a randomized design, we develop risk-adjusted treatment styles that control for differences across physicians in the observed characteristics of their patients. For each physician in each year of practice, we separately measure the overall c-section rate, elective c-section rate, and c-section rate conditional on labor.

To derive a physician's overall risk-adjusted c-section rate, for example, we estimate the following linear probability model, separately for each year between 1992 and 2003:

$$(2) \qquad C_{ij} = \boldsymbol{\alpha X}_i + \mathbf{YJ} + \varepsilon_{ij}$$

C_{ij} equals one if patient i received a c-section by physician j and is zero otherwise. We include patient characteristics **X**, such as the patient's age, type of health insurance, existing medical conditions (e.g., severe hypertension), and the status of the pregnancy (e.g., multiple gestation, preterm gestation, antepartum bleeding, whether the woman had a c-section in a prior delivery) that may affect the risks and/or benefits of a c-section. We also include a full set of physician indicator variables **J** and do not include a constant. The coefficients on the physician indicators (**Y**) measure the probability that a particular physician will perform a c-section, controlling for observed characteristics of the mother's health and the status of the pregnancy.[7] In Table 3 we present selected coefficient estimates from the ordinary least squares estimation for 2003.

[7] We estimate equation (2) with ordinary least squares rather than a probit or logit model for expediency and because the coefficients on the physician indicators are easier to interpret with OLS. Our results are robust to using an alternative model. In 2003, for example, there is a correlation of 0.95 between the coefficients on the physician indicator variables from an OLS and a logit regression.

Although the primary purpose of this regression is to recover the coefficients on the physician indicator variables (**Y**), the coefficients on the patient characteristics (α) are interesting nonetheless. Although each health condition we include is present in fewer than three percent of women, most conditions substantially increase the chance a woman will have a c-section. Each coefficient can be interpreted as the average change in a patient's probability of receiving a c-section associated with a change in the independent variable. For example, a woman with severe hypertension has a probability of receiving a c-section that is 21 percentage points higher than women without that condition. A woman who had a prior c-section has a 67 percentage point higher probability of having a c-section on her current delivery relative to a woman who has not had a c-section before, and a woman with a malpositioned fetus is also much more highly to have a c-section than a woman whose fetus is in the vertex position. Hispanic women are slightly more likely to receive a c-section than white women, and women who have Medicaid and uninsured women are less likely to receive a c-section than women who have indemnity insurance or a PPO plan. Medicaid generally reimburses physicians and hospitals less than private insurers, so our result is consistent with Gruber, Kim, and Mayzlin's (1999) finding that higher fee differentials between c-sections and normal deliveries lead to higher c-section rates.

We perform similar regressions to derive a physician's risk-adjusted elective c-section rate and risk-adjusted c-section rate conditional on labor. The latter regression is estimated only on women who went into labor, and the dependent variable is one if she received a c-section and zero if she delivered vaginally.[8] After we run a separate regression like the one reported in Table 3 for each of the 12 years and each of the three practice style measures, we recover the physician coefficients and create a panel data set where observations are at the level of physician j's practice style for year t.

One concern is that the practice style measures may be noisy, imprecise estimates of a physician's true style. This could occur if the component of patient health that physicians observe and we do not has a substantial effect on treatment decisions, and the mean unobserved health of a physician's patient population changes substantially from year to year due, in part, to small patient volume. Limiting the sample to patients of physicians who perform deliveries 50 or more times per year should reduce the possibility of spurious treatment style measures. We find that the correlation between a physician's treatment style in year t and year t -1 is high, ranging from 0.65 for the c-section rate conditional on labor to 0.76 for the overall c-section rate.

Kane and Staiger (2002) develop a test to measure how much of the change in school test scores is due to non-persistent variation, such as high teacher-turnover in a school during a particular year, the chemistry between a teacher and her students, or test-taking conditions. If the correlation of the change in test scores in adjacent years is negative and large (i.e., a class that experienced a large increase from year 1 to year 2 tends to have a large decrease in scores from year 2 to year 3), most of the change is transitory; when the correlation is close to zero, most of the change is persistent and the scores are an accurate measure of performance.[9] When we apply this test, the proportion of the changes in physician treatment styles that are attributable to persistent factors ranges from 0.25 for the elective c-section rate, to 0.58 for the overall c-section rate.

3.3 Defining Local and Regional Peer Groups

We divide Florida into 11 health care markets using the Florida Department of Health's definition of local health districts, which consist of one or more contiguous counties. These markets are large enough so that 93 percent of the deliveries occur at a hospital in the same market where the mother resides. For each physician we construct a measure of the practice style of his local and regional peers. We define physician j's local peer group in year t as all physicians other than

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[8] Results from these regressions are available from the authors by request.

[9] Specifically, the proportion of the change in the performance measure that is due to non-persistent factors is equal to -2 multiplied by the correlation of the change in adjacent years (Kane and Staiger, (2002). This test assumes that the permanent and transitory shocks in adjacent years are independent.

physician j who delivered a baby at the same hospital(s) as physician j in year t.[10] Physician j's regional peer group in year t includes all physicians who delivered a baby at a hospital in the same market as physician j other than the hospital(s) where physician j delivered.[11] We use the physician-specific practice style coefficients for the members of physician j's local and regional peer groups to create delivery-weighted local and regional peer group treatment styles for each physician for each year, where the weight is the proportion of the total quantity of deliveries performed by the group (other than physician j) accounted for by each physician (other than physician j).

A physician is more likely to exchange clinical information with his local than his regional peers, but is likely to be affected by the same market-specific policies as his regional peers. We use this assumption to try to separate the influence of the local exchange of clinical information from policies that affect all physicians in a market. Sixty percent of the physicians in our data set delivered all their babies at a single hospital, 27 percent divided their deliveries between two hospitals, and 13 percent at three or more hospitals. The mean number of physicians in a local peer group is 20 and in a regional peer group is 67.

We present the means and standard deviations of the variables in the physician-year-level data set in Table 4. This data set contains 848 physicians representing 7,004 physician-years. Fourteen percent of the physicians are women and 85 percent are obstetricians/gynecologists. They have 13 years of post-residency experience and delivered 191 babies per year, on average.

3.4 Empirical Model

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[10] We pooled the experience of individual physicians with fewer than 50 deliveries in a year in hospital-specific residual groups and included these residuals in the peer group calculations.

[11] A physician who delivers in both a hospital where physician j delivers as well as a hospital in the same region where physician j does not deliver will appear in both physician j's local and regional peer groups. Although this will not bias our empirical estimates, it will make it more difficult to measure the separate effects of regional policies and of the local exchange of information. Fortunately, a majority of physicians in our sample deliver at a single hospital.

The first objective of this paper is to measure the amount of variation in treatment styles among obstetricians practicing in the same market. We argued above that a patient who is searching for a physician will care more about the variation in treatment styles among physicians within a market than across markets or regions. Our second objective is to examine why treatment styles differ between physicians. Our third objective is to determine whether physicians learn from their immediate colleagues and if this local learning leads to substantial changes in treatment styles over time.

In order to quantify the variation that exists between physicians within a market, we calculate the difference between a physician's treatment style (Y_{jt}, as estimated in equation (2)) and the mean treatment style for the physician's market in year t.[12] We then calculate the standard deviations of the within-market practice style measures for the overall risk-adjusted c-section rate, the risk-adjusted elective c-section rate, and the risk-adjusted c-section rate conditional on labor, and compare these to the between-market standard deviation.

For purposes of estimating the determinants of variation in physician treatment styles, each observation is a practice style measure for a physician-year. We pool the observations across the 12 years and 848 physicians and estimate a series of OLS regressions. We first regress the Y_{jt} on a full set of physician and year indicator variables. The R^2 from this regression represents the total amount of variation that can be explained by physician-specific and year-specific factors.

We use the incremental R^2 method proposed by Theil (1971) to decompose the total explained variation into incremental components that can be attributed to the year, region, physician characteristics, location of residency training, and all other unmeasured factors specific to a physician. To do this, we repeat the regression described above after replacing the physician indicator variables with indicator variables for a physician's gender, race, specialty, obstetrical residency program, region, a continuous variable measuring years of post-residency experience, and experience squared. We include indicator variables for the 15 residency programs that trained five or more physicians in our sample. The difference in the R^2 between the first and second regressions is the amount of variation due to time-invariant, physician-specific factors *other than* those we explicitly control for in the second regression (i.e., gender, race, specialty, location of training, and experience).

In order to measure the amount of variation explained by time, we remove the year indicator variables from the second regression, and measure the difference in the R^2 between the second and third regressions. After restoring the year indicators, we then successively omit from the second regression specification the region indicators, the physician characteristics, and the residency program indicators, and measure an incremental R^2 for each factor.

Our third objective is to examine whether physicians change their treatment styles based on clinical information acquired from peers. Manski (1993) notes that one of the major challenges of empirically estimating social interactions is to measure separately the effect on an individual's behavior of his peer group's behavior (in our context the treatment style of a physician's peers), unobserved characteristics shared by members of a peer group (e.g., technical skill or risk aversion), and the environment in which the members of a peer group operate (e.g., reimbursement incentives and the probability of being sued for malpractice).

In an ordinary least squares regression of a physician's treatment style on the style of his peer group, the coefficient on the latter variable would capture the net effect of all three factors. We address this problem by estimating fixed-effects models to control for unobserved characteristics that a physician may share in common with his peer group, and including two non-overlapping peer group variables rather than a single peer variable. Specifically, we perform a

[12] We derive the market risk-adjusted c-section rate by replacing the physician indicator variables in equation (2) with a complete set of 11 indicators for the Florida local health districts. The coefficient on a market indicator variable is the risk-adjusted c-section rate for that market in that year.

series of fixed-effect regressions where the dependent variable is physician j's treatment style in year t (Y_{jt}) and the complete specification has the following form:

$$(3) \qquad Y_{jt} = \gamma_0 + \gamma_1 L_{jt} + \gamma_2 R_{jt} + \gamma_3 L_{j,t-1} + \gamma_4 R_{j,t-1} + \boldsymbol{\gamma_5 T} + \mu_j + v_{jt}$$

T is a set of year indicators that will capture the trend in how babies were delivered in Florida over the 1992 to 2003 time period, including the effect of state policies and changes in national clinical guidelines.[13] L_{jt} is the contemporaneous treatment style in year t for physician j's local peer group (physicians who perform deliveries at the same hospital(s) as physician j) and R_{jt} is the treatment style of physician j's regional peer group (physicians in j's market who deliver babies at hospitals *other than* those where physician j delivers babies). The coefficient γ_1 measures the change in physician j's treatment style associated with a change in the treatment style of his local peer group, and likewise for γ_2 with respect to his regional peer group.

A physician may be more likely to join a practice or locate in a market populated with physicians who share a personal characteristic that we do not observe, such as technical skill. In a fixed-effects model, the coefficients γ_1 and γ_2 are identified by variations over time in the practice style of a physician's peers. Any unobserved characteristic that is time invariant, such as the technical skill of a physician and his peers, will drop out. In an ordinary least squares regression, γ_1 and γ_2 would be biased upward.

If one includes a single peer group variable in equation (3), the coefficient would capture the causal effect of both changes in the practice style of a physician's peers on changes in his own practice style, and the effect of policies and shocks (e.g., changes in patients' preferences or changes in private health insurance reimbursement incentives) on changes in the treatment styles of all physicians in the same market. We try to separately measure these two effects by including both the local (L_{jt}) and regional (R_{jt}) peer group measures. Consider a situation where members

[13] In 2000, for example, the American College of Obstetricians and Gynecologists proposed a c-section benchmark of 15.5 percent women at 37 weeks of gestation or greater, having their first child, with a single

of a physician's local and regional peer groups are exposed to the same policies and shocks. When physicians with distinctive treatment styles enter or exit a local peer group, L_j will change differently between t-1 and t than R_j. The coefficient γ_2 will capture the impact of market-level policies and shocks on a physician's treatment style, and the coefficient γ_1 will capture the incremental, causal effect of a change in the local peer group's treatment style on physician j's treatment style.[14]

Under this set of assumptions, γ_1 provides an upper-bound estimate of the effect of new clinical information on a physician's treatment decisions. If there are policies and shocks that affect a physician's local peers differently than his regional peers, such as a change in patient preferences by a subset of the patients in a market, a change in reimbursement incentives for a single physician group practice, or a clinical policy initiated by a single hospital, then γ_1 will overstate the amount of learning due solely to the exchange of clinical information. Even in this case, however, comparing the magnitudes of γ_1 and γ_2 will still illuminate the importance of local versus regional factors in determining treatment decisions.

We would like to identify γ_1 and γ_2 with exogenous changes in the composition of a physician's peer group due to retirement, relocation, and the arrival of newly-trained physicians. There was considerable turnover of obstetricians in Florida over the sample period. Between 1993 and 2003, an average of 18.8 obstetricians exited the sample each year because they stopped practicing, stopped delivering babies, or moved out of Florida, and 19.3 obstetricians entered the sample per year. Our identifying assumption is that changes in the practice style of a physician's peer group are exogenous with respect to expected changes in the physician's practice style and policies that are expected to affect the physician's practice style.

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fetus in the vertex (non-breech) position (American College of Obstetricians and Gynecologists, 2000). The report contained a number of specific recommendations to help obstetricians meet this goal.

[14] Hong, Kubik, and Stein (2003) use a similar method. They allow the stock-holding decisions of a mutual fund manager to be affected differently by the decisions of other managers in the same geographic market and managers in more remote geographic markets.

The estimated practice style for each physician will capture differences between physicians in their perceptions of the appropriateness of c-sections, and differences across physicians in unobserved (by us) patient characteristics. For this analysis we are interested only in the former component. Women with strong preferences for having a c-section and women with unobserved health characteristics that increase the benefits of a c-section may select particular physicians who specialize in the procedure.[15] Another benefit of using a fixed-effects model is that the component of Y_j that is due to unobserved, time-invariant patient characteristics (μ_j) will be eliminated.

In order to examine how quickly physicians respond to new information, in one specification we add lagged measures of the treatment styles of a physician's regional and local peer groups, $R_{j,t-1}$ and $L_{j,t-1}$. Our hypothesis is that physicians will incorporate new information obtained from local sources more quickly than regional sources, because physicians interact more regularly and more intensively with their local peers than their regional peers. A significant γ_4 coefficient and an insignificant γ_3 coefficient would be consistent with this hypothesis. In the final specification we interact the peer group practice style variables with a physician's experience to see if younger physicians are influenced more strongly than older physicians, which would be consistent with the Bayesian learning model in Phelps and Mooney (1993).

The dependent variables in the second stage (equation 3), Y_{jt}, are themselves estimated from the first stage, patient-level regressions (equation 2). To increase efficiency, we would like to weight the second stage regressions with the inverse of the standard errors of Y_{jt} from the first stage.[16] Weighting in this manner places greater emphasis high-volume physicians who have more precisely estimated treatment style coefficients. Because we are unable use weights with a

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[15] Most obstetricians are members of a group practice, and it is common for a single obstetrician in a group to perform all of the practice's deliveries between, say, 5pm and 7am the following day. Many women, therefore, choose their preferred obstetrics practice but not the actual physician who will deliver her child. The randomness of many patient-physician matches will reduce the component of Y_j that is due to unmeasured patient characteristics.

[16] Grant and McInnes (2004) and Shen (2003) use the same method.

fixed effects model, we also estimate first-difference versions of equation (3) where we use the inverse of the first-stage standard errors as weights. The results from the first-difference regressions are very similar to those from the fixed effects model, as discussed below.

4. Results

Phelps and Parente (1990) estimate there is an annual welfare loss of $33 billion (in 1987 dollars) due to practice variations, based on variations in treatment rates between New York counties. The true welfare loss will be higher if physician treatment styles vary within a market. To estimate the amount of within-market variation, we calculate the difference between each physician's treatment style and the market average for year t. We pool these observations over the 1992 to 2003 time period and depict the distribution separately for the three treatment styles in Figure 2. In 30 percent of the cases the physician's risk-adjusted c-section rate in the first panel of Figure 2 is statistically different from the regional mean at the five percent level.[17] The standard deviation of the within-market variation in risk-adjusted c-section rates is 6.0 percentage points, more than twice the variation across regions at a point in time (reported at the bottom of Table 1). The within-market variations for the elective c-section rate and c-section rate conditional on labor are also two to three times larger than the between-market variation. Two identical women who live in the same market and choose their obstetricians randomly are likely to have very different *ex ante* probabilities of receiving a c-section. Thus health insurers and the government may be substantially underestimating the benefit of standardizing physicians' treatment methods.

One concern is that measurement error may exaggerate the amount of variation that actually exists between physicians in their treatment styles. When we apply a Bayesian shrinkage technique (Hofer *et al*., 1999) to account for each physician's signal-to-noise ratio, the within-

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[17] This is similar to the result in Phelps (2000) where one-third of the primary care physicians have mean expenditures per patient that differ from the market average.

market variation for 1992 is reduced by 19 percent (the standard deviation decreases from 6.5 to 5.3 percentage points). Our results, therefore, are not an artifact of measurement error.

We decompose the total explained variation in treatment styles into incremental components that can be attributed to the year, region, physician characteristics, location of residency training, and all other unmeasured factors specific to a physician. We separately examine all physicians and inexperienced physicians – those with fewer than 4 years of post-residency experience – to test whether the impacts of residency training and physician characteristics diminish over a physician's career. Results are reported in Table 5. The year indicators explain 20 to 30 percent of the variation in treatment styles of experienced physicians, whereas the regional indicators account for three to six percent. Physician characteristics and the 15 residency program indicators explain very little of the variation. Apparently residency programs do not produce obstetricians with distinct views regarding how patients should be treated, or these differences dissipate quickly once physicians begin practicing.[18]

Over 30 percent of the variation in treatment styles among experienced physicians is due to time-invariant, physician-specific factors that are not associated with where a physician trained, his experience, gender, or race. Because we have detailed information on patient characteristics, our interpretation is that a considerable amount of practice variation is due to idiosyncratic physician perceptions regarding how patients should be treated. Grytten and Sorensen (2003) find that physician-specific effects explain slightly more than half of the variation in average medical spending per patient among primary care physicians in Norway. However, they have a much more limited set of risk adjusters (the gender mix and average age of a physician's patients only), so there is likely to be more unobserved patient heterogeneity across practices in their sample than in ours.

[18] An alternative explanation is that the time-invariant coding of residency programs misses important variation over time in the styles that residency programs impart to their trainees.

The results for physicians with fewer than four years of post-residency experience are reported in the final three columns of Table 5. Relative to the all-physician analysis, less of the variation in treatment styles among inexperienced physicians is attributed to time and more is attributed to physician characteristics and location of training. Nevertheless, residency programs still explain less than four percent of the variation. We expected residency programs to have a relatively strong effect on the practice styles of newly trained physicians, before they fully incorporated the practice styles of their peers and the health outcomes of their own patients into treatment decisions.

In Tables 6-8 we examine whether and why physician treatment styles change over time. In the fixed effects specification reported in column 1 we include the contemporaneous treatment style of physician j's regional peer group, R_{jt} – the physicians in j's market who deliver babies at hospitals other than those where physician j delivers babies—and year indicators. The coefficient on R_{jt}, which is identified by within-market variations in regional peer groups' treatment styles over time, is positive and significant. A one percentage point increase in the c-section rate of a physician's regional peer group *relative* to the state average is associated with a 0.14 percentage point increase in the physician's own c-section rate. Although physicians' treatment styles generally move together, the correlation between individual physicians is relatively low. This is consistent with our results in Table 5 that a considerable amount of the variation between physicians in their treatment styles is due to differences in their perceptions regarding treatment efficacy and appropriateness.

In the second column of Table 6 we include the risk-adjusted c-section rate of a physician's local peers. A one percentage point increase in the overall c-section rate of a physician's immediate colleagues is associated with an increase of 0.046 percentage points in his own rate. As discussed above, this coefficient is an upper-bound estimate of the effect of new clinical information on a physician's treatment decisions. The local exchange of information has a statistically significant but rather small effect on obstetricians' treatment styles. A one-standard deviation (10.9 percentage points) increase in a physician's local peer rate is associated with a 0.50 percentage point (or 3.5 percent) increase in his own rate.

Although the coefficient on the regional peer group decreases when the local peer variable is included, it is twice as large as the coefficient on the local peer group. Market policies and shocks appear to have a more substantial effect on physicians' treatment decisions than does the local exchange of information. However, both of these effects are small. Consider an obstetrician whose risk-adjusted c-section rate is at the 90th percentile in Florida for 2003. If the c-section rates of his regional and local peer groups both decrease by one standard deviation, his c-section rate is predicted to decrease by 1.1 percentage points, which would now place him at the 88th percentile.

We include the lagged regional and local peer group treatment styles in column 3 of Table 6.[19] For the regional peer group variables, the contemporaneous coefficient is insignificant and the lagged coefficient is significant, whereas for the local peer group variables the opposite pattern holds. This suggests that, as expected, physicians take a longer time to respond to a market policy/shock than to a change in the local information set. In the final specification in column 4 we interact each of the two peer group variables with a physician's years of post-residency experience. The impact of a market shock/policy does not differ according to a physician's experience, whereas a change in the treatment style of a local peer group has a relatively strong effect on inexperienced physicians. A one-standard deviation increase in the risk-adjusted c-section rate of a local peer group is predicted to increase a new obstetrician's risk-adjusted c-section rate by 6.0 percent, versus 3.0 percent for an obstetrician with 16 years of experience.

In Table 7 we present fixed effect coefficient estimates from a regression in which the dependent variable is a physician's risk-adjusted elective c-section rate – the proportion of deliveries that are c-sections and the woman does not go into labor. As with the overall risk-adjusted c-section rate, both the regional and local peer group coefficients are positive and significant in column 2, and the regional effect is twice as large as the local effect. The two peer group coefficients are about twice as large in magnitude as in Table 6, which indicates that market and local shocks have a particularly strong effect on elective c-sections. Recall from Figure 1 that the pronounced increase in Florida's c-section rate since 1997 has been driven largely by an increase in the proportion of deliveries that are elective, scheduled c-sections. A one-standard deviation increase in the elective c-section rate of a physician's market and local peers are each predicted to increase his rate by 0.6 percentage points (from 4.7 percentage points to 5.3 percentage points), or 12 percent. The coefficients on the lagged regional and lagged local peer group treatment styles are both significant in column 3, which indicates that it takes time for regional and local shocks to affect a physician's elective c-section rate.

In Table 8 we report coefficient estimates for a physician's risk-adjusted c-section rate conditional on a woman going into labor. The pattern of coefficients is generally similar to those in Table 6 and Table 7, although physician treatment styles are less responsive to market and local shocks. As before, physicians respond more quickly to changes in their local information set than to market policies/shocks, and inexperienced physicians are influenced more substantially than experienced physicians.

We also estimate first-difference versions of equation (3) where we weight the observations with the multiplicative inverse of the first-stage standard errors. This places a greater weight on high-volume physicians, who have more precisely estimated treatment style coefficients. In Table 9 we report coefficient estimates for the first-difference specification that includes the contemporaneous and lagged measures of the two peer group variables. The results are generally consistent with the fixed effect model results in column 3, although the coefficients are not as precisely estimated. Of particular interest, in all three regressions the coefficients on the change from t-1 to t in a local peer group's practice style (0.041, 0.087, and 0.036) are very

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[19] Note that the sample size diminishes by over 800 observations when we include the lagged variables.

close to the fixed effect coefficients on the contemporaneous local practice style from column 3 of Tables 6-8 (0.044, 0.10, and 0.037). This provides evidence that the results are robust when we account for the fact that the dependent variables are themselves estimates.

5. Conclusions

In this paper we investigate how obstetricians form their treatment styles, and whether and how much their styles evolve over time. We assemble a comprehensive data set that contains the universe of inpatient births in Florida over a 12-year period matched with detailed information on the physicians performing the deliveries. Because the data contain consistent physician identifiers, we are able to examine physicians' treatment decisions over an extended time period. We construct annual measures of each physician's propensity to provide cesarean section that control for a range of patient health and demographic characteristics. We then examine the influence of physician-level attributes on practice styles, focusing on the role of residency training, learning from peers, and market factors. To isolate the effect of peer groups from market factors, we explore the relative contributions of other physicians practicing at the same hospitals as a given physician (the "local" peer group) as well as physicians practicing at different hospitals in the same market (the "regional" peer group).

As with most medical care treatments, differences in the mean c-section rates between the 11 regions of Florida, controlling for patients' observed characteristics, are quite large. In 2003, for example, the risk-adjusted probability a woman would have a cesarean section ranged from a low of 0.188 in Northwest Florida to a high of 0.273 in Miami. We show that there are even larger differences in c-section rates among physicians within a region; the standard deviation of the c-section rate across physicians within a region is more than twice as large as the between-region variation, controlling for observed patient characteristics. This implies that existing estimates of the welfare loss stemming from practice variation are too low, and payers may be underestimating the value of standardizing treatment methods.

Physician demographic factors and training experiences appear to have a small effect on inter-physician variation in the type of medical care received. Less than 1 percent of the variation in c-section rates among all physicians can be explained by where they trained as a resident. Likewise, a physician's experience, gender, and race account for around 2 percent of the variation in c-section rates. Over 30 percent of the variation in risk-adjusted c-section rates among all physicians is due to time-invariant, physician-specific factors other than experience, gender, race, and where a physician received residency training. The explanatory power of these factors is somewhat higher among new physicians. Because we have detailed information on the characteristics of a physician's patients, our interpretation is that a considerable amount of practice variation is due to idiosyncratic physician styles.

The importance of the exchange of information with a local peer group and market-wide policy shocks is similarly muted. A one percentage point increase in the overall c-section rate of a physician's local peer group yields a 0.046 percentage point increase in his own rate, roughly half the 0.11 percentage point increase associated with a one percentage point increase in the regional peer group's overall c-section rate. These relationships hold more or less for the elective c-section rate and the c-section rate conditional on maternal labor as well.

Physicians appear to be quite independent. Treatment styles are not strongly shaped by residency training programs and are rather impervious to market-specific shocks and changes in peer treatment styles. Although physicians learn from their peers, especially relatively inexperienced physicians, they do not substantially revise their prior beliefs regarding how patients should be treated due to the local exchange of information. Our finding in Table 5, however, that the year variables explain a considerable amount of the variation indicates that national forces, such as a change in clinical guidelines and changes in patient preferences, do have a strong influence on treatment styles. Taken together, these results imply that cross-sectional variations in regional treatment rates that are commonly observed are unlikely to dissipate substantially over time, nor is the within-market variation across physicians likely to dissipate over time due to convergence to a community standard. This is in contrast to the predictions of Phelps and Mooney (1993), who postulate that in the long run there will be inter-market variation in practice patterns but little intra-market variation across physicians.

References

American College of Obstetricians and Gynecologists: *Evaluation of Cesarean Delivery*., 2000. Washington, D.C.: ACOG.

Banerjee, Abhijit V., 1992, "A Simple Model of Herd Behavior," *Quarterly Journal of Economics* 107(3): 797-817.

Bikhchandani, Sushil, David Hirschleifer, and Ivo Welch, 1992, "A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades," *Journal of Political Economy* 100(5): 992-1026.

Bikhchandani, Sushil, Amitabh Chandra, Dana Goldman, and Ivo Welch, 2001, "The Economics of Iatroepidemics: Bayesian Learning, Informational Cascades and Geographical Variation," working paper..

Chassin, Mark R., Robert H. Brook, R.E. Park, Joan Keesey, Arlene Fink, Jacqueline Kosecoff, Katherine Kahn, Nancy Merrick, and David H. Solomon, 1986, "Variations in the Use of Medical and Surgical Services By the Medicare Population," *The New England Journal of Medicine* 314(5): 285-290.

Chetty, V. K., 1998, "Stochastic Technology, Production Organization and Costs," *Journal of Health Economics* 17(2): 187-210.

Ellison, Glenn, and Drew Fudenberg, 1993, "Rules of Thumb for Social Learning," *Journal of Political Economy* 101(4): 612-643.

Ellison, Glenn, and Drew Fudenberg, 1995, "Word-of-Mouth Communication and Social Learning," *Quarterly Journal of Economics* 110(1): 93-125.

Epstein, Andrew, Jonathan Ketcham, and Sean Nicholson, 2005, "Physician Specialization and Patient Sorting in Obstetrics," working paper.

Escarce, Jose J., 1996, "Externalities in Hospitals and Physician Adoption of a New Surgical Technology: An Exploratory Analysis," *Journal of Health Economics* 15: 715-734.

Evans, W., W. Oates, and R. Schwab, 1996, "Measuring Peer Group Effects: A Study of Teenage Behavior," *Journal of Political Economy* 100: 966-991.

Gaviria, Alejandro, and Steven Raphael, 2001, "School-Based Peer Effects and Juvenile Behavior," *Review of Economics and Statistics* 83(2): 257-268.

Glaeser, Edward L., Bruce Sacerdote, and Jose A. Scheinkman, 1996, "Crime and Social Interactions," *Quarterly Journal of Economics* 111(2): 507-548.

Goyert, Gregory L., Sidney F. Bottoms, Marjorie C. Treadwell, and Paul C. Nehra, 1989, "The Physician Factor in Cesarean Birth Rates," *The New England Journal of Medicine* 320(11): 706-709.

Grant, Darren, and Melayne Morgan McInnes, 2004, "Malpractice Experience and the Incidence of Cesarean Delivery: A Physician-Level Longitudinal Analysis," *Inquiry* 41: 170-188.

Gregory, Kimberly D., Lisa M. Korst, Jeffrey A. Gornbein, and Lawrence D. Platt, 2002, "Using Administrative Data to Identify Indications for Elective Primary Cesarean Delivery," *Health Services Research* 37(5): 1387-1401.

Gruber, Jon, John Kim, and Dina Mayzlin, 1999, "Physician Fees and Procedure Intensity: the Case of Cesarean Delivery," *Journal of Health Economics* 18: 473-490.

Grytten, Jostein, and Rune Sorensen, 2003, "Practice Variation and Physician-Specific Effects," *Journal of Health Economics* 22(3): 403-418.

Henry, Olivia A., Kimberly D. Gregory, Calvin J. Hobel, and Lawrence D. Platt, 1995, "Using ICD-9 Codes to Identify Indications for Primary and Repeat Cesarean Sections: Agreement With Clinical Records," *American Journal of Public Health* 85(8): 1143-1145.

Hofer, Timothy P., Rodney A. Hayward, Sheldon Greenfield, Edward H. Wagner, Sherrie H. Kaplan, and Willard G. Manning, 1999, "The Unreliability of Individual Physician 'Report Cards' for Assessing the Costs and Quality of Care of a Chronic Disease," *JAMA* 281(22): 2098-2105.

Hong, Harrison, Jeffrey D. Kubik, and Jeremy C. Stein, 2003, "Thy Neighbor's Portfolio: Word-of-Mouth Effects in the Holdings and Trades of Money Managers," NBER Working Paper 9711.

Kane, Thomas J., and Douglas O. Staiger, 2002, "Volatility in School Test Scores: Implications for Test-Based Accountability Systems," in *Brookings Papers on Education Policy*. Diane Ravitch, ed. Washington, D.C.: Brooking Institution: 235-283.

Manski, Charles, 1993, "Identification of Endogenous Social Effects: The Reflection Problem," *Review of Economic Studies* 60: 531-542.

Newhouse, Joseph P., 2002, "Why is there a Quality Chasm?" *Health Affairs*, 21(4): 13-25.

Phelps, Charles E., and S. Parente, 1990, "Priority Setting for Medical Technology and Medical Practice Assessment," *Medical Care* 28(8): 703-723.

Phelps, Charles E., and Cathleen Mooney, 1993, "Variations in Medical Practice Use: Causes and Consequences," in R.J. Arnould, R.F. Rich, and W. White, eds., Competitive Approaches to Health Care Reform. Washington, D.C.: Urban Institute Press.

Phelps, Charles E., 2000, " Information Diffusion and Best Practice Adoption," in A.J. Cuyler, and J.P. Newhouse, eds., Handbook of Health Economics. Amsterdam: Elsevier Science.

Roos, Noralou P., Gordon Flowerdew, Andre Wajda, and Robert B. Tate, 1986, "Variations in Physicians' Hospitalization Practices: A Population-Based Study in Manitoba, Canada," *American Journal of Public Health* 76(1): 45-51.

Scharfstein, David S., and Jeremy C. Stein, 1990, "Herd Behavior and Investment," *American Economic Review* 80(2): 465-479.

Shen, Yu-Chu, 2003, "The Effect of Financial Pressure on the Quality of Care in Hospitals," *Journal of Health Economics* 22(2): 243-269.

Stano, Miron, and Sherman Folland, 1988, “Variations in the Use of Physician Services by Medicare Beneficiaries,” *Health Care Financing Review* 9(3): 51-58.

Stano, Miron, 1993, “Evaluating the Policy Role of the Small Area Variations and Physician Practice Style Hypotheses,” *Health Policy* 24(1): 9-17.

Theil, H., 1971. *Principles of Econometrics*. New York, NY: John Wiley & Sons, Inc..

Welch, H. Gilbert, Mark E. Miller, and W. Pete Welch, 1994, “Physician Profiling: An Analysis of Inpatient Practice Patterns in Florida and Oregon,” *The New England Journal of Medicine* 330(9): 607-612.

Wennberg, John E., and A. Gittelsohn, 1973, “Small Area Variations in Health Care Delivery,” *Science* 182: 1102-1108.

Wennberg, John E., J.L. Freeman, and W.J. Culp, 1987, “Are Hospital Services Rationed in New Haven or Over-Utilised in Boston?,” *Lancet* 1: 1185-1189.

Wennberg, John E., Elliott S. Fisher, and Jonathan Skinner, 2002, “Geography and the Debate Over Medicare Reform,” *Health Affairs*, Web Exclusive, February 13, 2002.

Wennberg, John E., 1985, “On Patient Need, Equity, Supplier-Induced Demand, and the Need to Assess the Outcome of Common Medical Practices,” *Medical Care* 23(5): 512-520.

Table 1: Variation in Obstetrical Treatment Styles Between Florida Regions, 2003

Florida local health district	Risk-adjusted c-section rate	Risk-adjusted scheduled c-section rate	Risk-adjusted c-section rate conditional on labor
1	0.188	0.068	0.152
4	0.192	0.072	0.150
7	0.204	0.084	0.151
3	0.205	0.080	0.159
6	0.217	0.081	0.169
2	0.217	0.090	0.167
8	0.220	0.086	0.171
5	0.229	0.090	0.175
9	0.231	0.102	0.170
10	0.258	0.114	0.190
11	0.273	0.118	0.209
Mean	0.221	0.090	0.169
Standard deviation	0.026	0.016	0.018
Coefficient of variation	0.12	0.18	0.11

Note: a region is defined as one of the 11 local health districts in Florida. We use variables displayed in Table 2 to adjust the probability a patient receives a c-section for her health, the status of the pregnancy, and type of insurance coverage.

Table 2: Sample Means and Standard Deviations in Patient-level Data Set

(n = 2,258,674)

	Mean	Standard Deviation
Age	26.9	6.23
Race/ethnicity		
- White	0.556	0.497
- Black	0.211	0.408
- Hispanic	0.171	0.376
- Other race	0.062	0.241
Health insurance		
- PPO and indemnity	0.271	0.445
- HMO	0.230	0.421
- Other private insurance	0.025	0.157
- Medicaid	0.396	0.489
- Uninsured	0.078	0.269
Woman's health condition:		
Woman has had a previous c-section	0.129	0.335
Malpositioned fetus	0.061	0.239
Antepartum bleeding	0.018	0.131
Severe hypertension	0.011	0.105
Preterm gestation	0.071	0.257
Multiple gestation	0.010	0.100
Maternal soft tissue disorder	0.022	0.146
Macrosomia	0.029	0.167
Oligohydramnios	0.006	0.074
Polyhydramnios	0.022	0.145
Herpes	0.014	0.119
Uterine scar unrelated to prior c-section	0.002	0.039
Uterine rupture	0.001	0.028
Unengaged fetal head	0.011	0.0064
Congenital fetal CNS anomaly	0.001	0.031
Cerebral hemorrhage	0.0001	0.007
Diabetes	0.008	0.091
Chorioamnionitis	0.022	0.146
Ruptured membrane > 24 hours	0.013	0.113
Maternal hypotension	0.001	0.034
Intrauterine growth restriction	0.015	0.123
Maternal heart disease	0.012	0.107
Asthma	0.012	0.109
Maternal renal abnormality	0.001	0.034
Other maternal infection	0.013	0.113

Table 3: Selected Coefficient Estimates From a Patient-level Cross-Section Regression, 2003

	Coefficient	Standard Error
Age	-0.0076**	0.0010
Age squared	0.00017**	0.00002
Black	0.0022	0.0023
Hispanic	0.0067**	0.0024
Health insurance (PPO and indemnity omitted)		
- HMO	-0.0006	0.0024
- Medicaid	-0.020**	0.0024
- Other private insurance	-0.0088	0.0057
- Uninsured	-0.043**	0.0038
Health of mother or baby:		
Woman has had a previous c-section	0.67**	0.0023
Malpositioned fetus	0.47**	0.0032
Antepartum bleeding	0.32**	0.0058
Severe hypertension	0.21**	0.0075
Preterm gestation	-0.0029	0.0032
Multiple gestation	0.21**	0.0078
Maternal soft tissue disorder	0.17**	0.0046
Macrosomia	0.33**	0.0044
Oligohydramnios	0.13**	0.0093
Polyhydramnios	0.14**	0.0050
Herpes	0.18**	0.0058
Uterine scar	0.44**	0.015
Uterine rupture	0.16**	0.040
Unengaged fetal head	0.68**	0.0064
Congenital fetal CNS anomaly	0.13**	0.023
Cerebral hemorrhage	0.24*	0.14
Diabetes	0.066**	0.0067
Chorioamnionitis	0.22**	0.0063
Ruptured membrane > 24 hours	0.045**	0.0074
Maternal hypotension	0.071**	0.022
Intrauterine growth restriction	0.10**	0.0061
Maternal heart disease	0.030**	0.0066
Asthma	0.034**	0.0058
Maternal renal abnormality	0.037**	0.019
Other maternal infection	0.074**	0.0066
Observations	202,022	
R^2	0.63	
Mean of dependent variable	0.33	

Notes: Dependent variable is an indicator for whether a woman received a c-section. We include a full set of physician indicator variables in the above regression and omit the constant. We also include indicators for whether a patient's race is missing, whether her age is missing, and various other health measures. Indicators are included for eight other health conditions (e.g., thyroid abnormality). ** = significantly different from zero at the 5-percent level; * = significantly different from zero at the 10-percent level.

Table 4: Sample Means and Standard Deviations in Physician-level Data Set

	Mean	Standard Deviation
Physician characteristics:		
Female	0.143	0.350
Gender information missing	0.094	0.292
Non-white	0.088	0.283
Race information missing	0.692	0.462
Post-residency experience (years)	13.4	7.68
Specialty		
- ob/gyn	0.851	0.364
- family practice/internal medicine	0.004	0.063
- maternal and fetal medicine	0.021	0.143
- information missing	0.119	0.324
Physician's practice characteristics:		
Number of deliveries	191	125
Unadjusted c-section rate	0.263	0.093
Risk adjusted c-section rate	0.143	0.078
Unadjusted elective c-section rate	0.150	0.077
Risk-adjusted elective c-section rate	0.047	0.051
Unadjusted c-section rate | labor	0.134	0.059
Risk-adjusted c-section rate | labor	0.121	0.064
Local peer group's practice characteristics:		
Risk-adjusted c-section rate	0.143	0.109
Risk-adjusted elective c-section rate	0.054	0.049
Risk-adjusted c-section rate | labor	0.120	0.088
Regional peer group's practice characteristics:		
Risk-adjusted c-section rate	0.140	0.053
Risk-adjusted elective c-section rate	0.052	0.026
Risk-adjusted c-section rate | labor	0.119	0.042

n = 7,004 physician-years

Note: There are 848 physicians in the panel data set. A physician's risk adjusted c-section rate is the coefficient on a physician indictor in a cross-section ordinary least squares regression where the unit of observation is a delivery and dependent variable is one if a woman received a c-section, and zero otherwise. A physician's risk-adjusted elective c-section rate and c-section rate conditional on labor are likewise coefficients on physician indicator variables where the dependent variable is one if a woman received an elective c-section and one if she received a c-section conditional upon going into labor, respectively.

Table 5: Sources of Variation in Physicians' Practice Styles

	Incremental R^2					
	All Physicians (n = 7,004)			Physicians With Fewer Than 4 Years Experience (n = 510)		
	C-section rate	Elective c-section rate	C-section rate | labor	C-section rate	Elective c-section rate	C-section rate | labor
Year indicators	0.300	0.217	0.301	0.170	0.157	0.165
Regional indicators	0.056	0.029	0.058	0.059	0.029	0.064
Physician characteristics: gender race, experience, and specialty	0.024	0.024	0.016	0.058	0.090	0.034
Residency program indicators	0.004	0.005	0.004	0.039	0.018	0.037
Variation common to the above variables	0.039	0.049	0.025	0.046	0.017	0.115
Physician indicators	0.348	0.360	0.307	0.447	0.488	0.375
Total variation explained	0.771	0.684	0.711	0.819	0.799	0.790

Notes: Observations are physician-year practice style measures, pooled from 1992 to 2003. There are 848 unique physicians in the data set, of whom 200 had fewer than four years of experience at some point. The practice style measures are adjusted for observed patient characteristics such as patient's age and health. The incremental R^2 for the physician indicators is the difference between the R^2 when physician and year indicators are included in the regression and the R^2 when the physician indicators are omitted but all other variables are included. Indicators were included for the 15 residency programs in which five or more physicians received their obstetrical/gynecology residency training.

Table 6: Fixed Effect Coefficient Estimates of a Physician's Risk-Adjusted C-section Rate

	(1)	(2)	(3)	(4)
Regional peer group's	0.14**	0.11**	0.0061	0.12**
c-section rate, t	(0.025)	(0.026)	(0.031)	(0.034)
Regional peer group's			0.10**	
c-section rate, t-1			(0.031)	
Regional peer group's rate in				-0.0015
year t * MD's experience				(0.0016)
Local peer group's		0.046**	0.044**	0.079**
c-section rate, t		(0.0069)	(0.0081)	(0.016)
Local peer group's			0.0064	
c-section rate, t-1			(0.0083)	
Local peer group's rate in				-0.0025**
year t * MD's experience				(0.0010)
Constant	0.13**	0.12**	0.11**	0.12**
	(0.0039)	(0.0039)	(0.0053)	(0.0039)
Year indicators:	YES	YES	YES	YES
Observations	7004	7004	6137	7004
R^2	0.33	0.34	0.37	0.33
Mean of dependent variable	0.143	0.143	0.142	0.143

Notes: The dependent variable is a physician's risk-adjusted c-section rate in year t. ** = significantly different from zero at the 5-percent level. * = significantly different from zero at the 10-percent level. There are 848 unique physicians in the panel data set.

Table 7: Fixed Effect Coefficient Estimates of a Physician's Risk-Adjusted Elective C-section Rate

	(1)	(2)	(3)	(4)
Regional peer group's	0.27**	0.21**	0.054	0.22**
elective c-section rate, t	(0.038)	(0.039)	(0.048)	(0.057)
Regional peer group's			0.16**	
elective c-section rate, t-1			(0.051)	
Regional peer group's rate in				0.0002
year t * MD's experience				(0.003)
Local peer group's elective		0.12**	0.10**	0.14**
c-section rate, t		(0.012)	(0.014)	(0.029)
Local peer group's elective			0.037*	
c-section rate, t-1			(0.014)	
Local peer group's rate in				-0.0017
year t * MD's experience				(0.0017)
Constant	0.011**	0.0086**	-0.0011	0.0082**
	(0.0017)	(0.0017)	(0.0022)	(0.0018)
Year indicators:	YES	YES	YES	YES
Observations	7004	7004	6137	7004
R^2	0.25	0.28	0.31	0.28
Mean of dependent variable	0.047	0.047	0.049	0.047

Notes: The dependent variable is a physician's risk-adjusted elective c-section rate in year t. ** = significantly different from zero at the 5-percent level. * = significantly different from zero at the 10-percent level. There are 848 unique physicians in the panel data set.

Table 8: Fixed Effect Coefficient Estimates of a Physician's Risk-Adjusted C-section Rate Conditional on Labor

	(1)	(2)	(3)	(4)
Regional peer group's c-section|labor rate, t	0.074**	0.045	-0.026	0.055
	(0.028)	(0.029)	(0.035)	(0.037)
Regional peer group's c-section|labor rate, t-1			0.072*	
			(0.033)	
Regional peer group's rate in year t * MD's experience				-0.0008
				(0.002)
Local peer group's c-section|labor rate, t		0.042**	0.037**	0.078**
		(0.0078)	(0.0090)	(0.017)
Local peer group's c-section|labor rate, t-1			0.0051	
			(0.0090)	
Local peer group's rate in year t * MD's experience				-0.0028**
				(0.0011)
Constant	0.14**	0.13**	0.13**	0.13**
	(0.0043)	(0.0043)	(0.0059)	(0.0043)
Year indicators:	YES	YES	YES	YES
Observations	7004	7004	6137	7004
R^2	0.31	0.32	0.33	0.31
Mean of dependent variable	0.121	0.121	0.118	0.121

Notes: The dependent variable is a physician's risk-adjusted c-section rate conditional on a patient going into labor in year t. ** = significantly different from zero at the 5-percent level. * = significantly different from zero at the 10-percent level. There are 848 unique physicians in the panel data set.

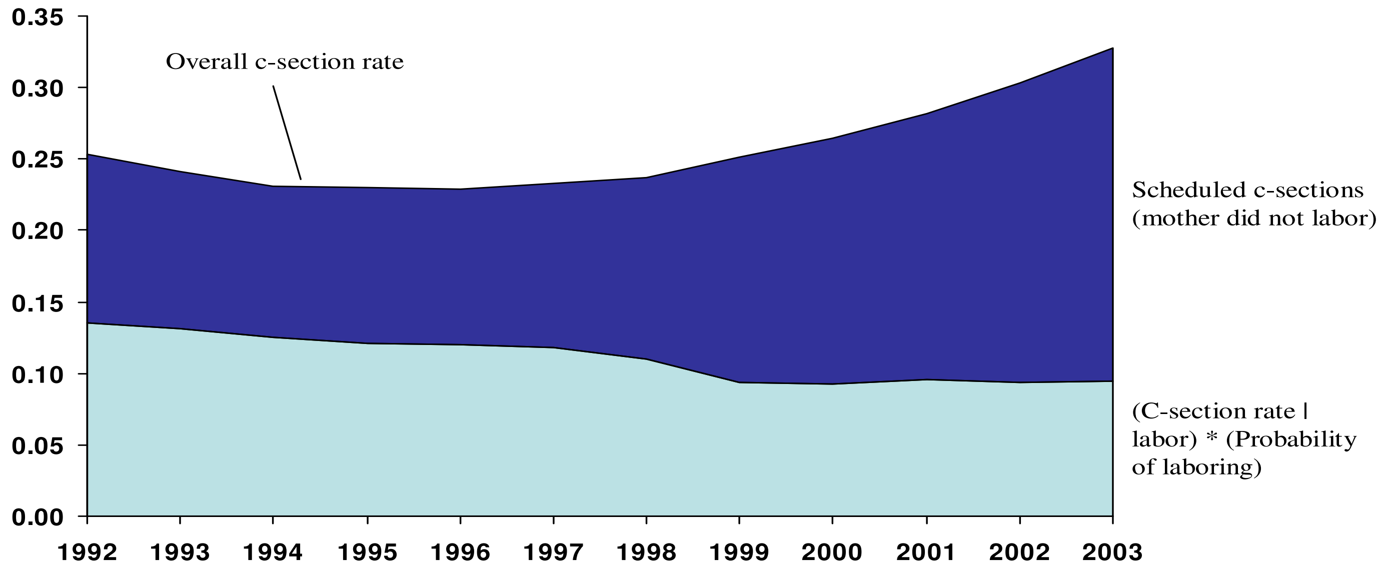
Table 9: First-Difference Coefficient Estimates

	Overall C-section rate	Elective C-section rate	C-section | labor rate
Change in regional peer group's rate, t-1 to t	-0.021	-0.0070	-0.031
	(0.032)	(0.051)	(0.037)
Change in regional peer group's rate, t-2 to t-1	0.060*	0.052	0.058
	(0.035)	(0.060)	(0.038)
Change in local peer group's rate, t-1 to t	0.041**	0.087**	0.036**
	(0.0088)	(0.014)	(0.011)
Change in local peer group's rate, t-2 to t-1	-0.0015	0.021	0.0025
	(0.0078)	(0.015)	(0.0094)
Constant	-0.019**	0.012**	-0.028**
	(0.0023)	(0.0014)	(0.0024)
Observations	5343	5343	5343
R^2	0.27	0.20	0.31
Mean of dependent variable	0.010	0.0075	0.0049

Notes: Dependent variable is the change in a physician's practice style between year t-1 and t. The practice style measures are adjusted for observed patient characteristics such as patient's age and health. The regressions are weighted by the reciprocal of the standard error of a physician's practice style measure from the first-stage, cross-sectional regression. Indicator variables are included for years. There are 848 unique physicians in the panel data set. ** = significantly different from zero at the 5-percent level; * = significantly different from zero at the 10-percent level.

Figure 1

Percentage of C-section Deliveries in Florida by Type, 1992-2003



Percentage of deliveries where the mother labored	**88.3%**	**89.1%**	**84.2%**	**77.7%**

Note: a delivery where a woman does not labor is classified as a scheduled c-section.

Within-Region Variation in Physician Practice Styles, 1992-2003

Figure 2a

Risk-adjusted c-section rates

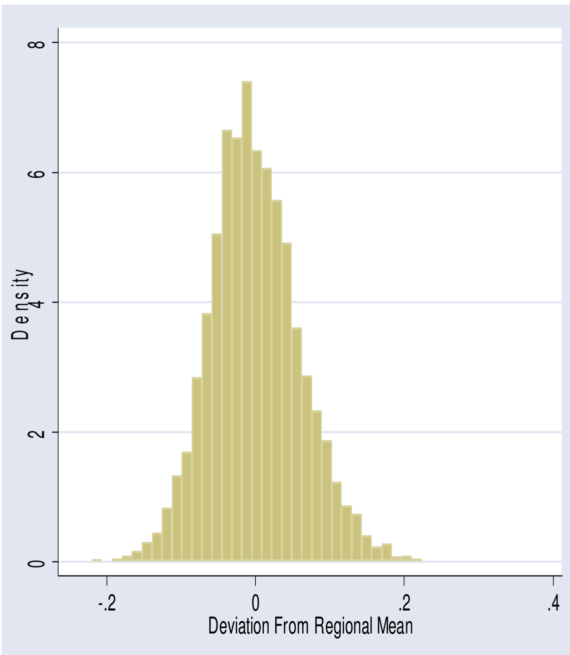


Figure 2b

Risk-adjusted scheduled c-section rates

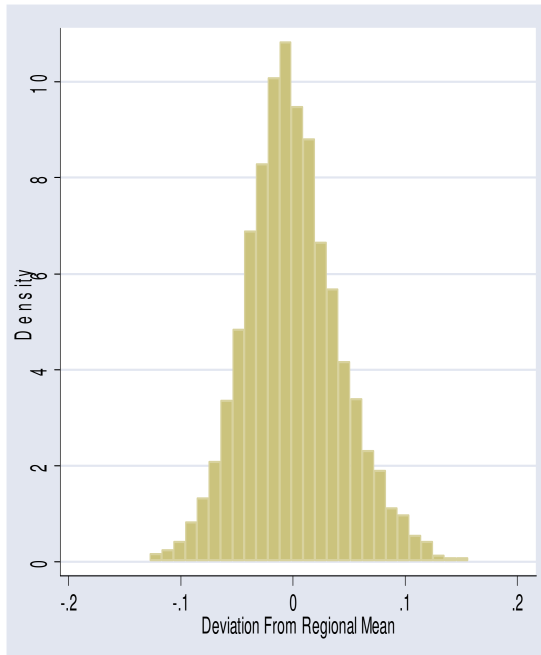


Figure 2c

Risk-adjusted c-section rates conditional on labor

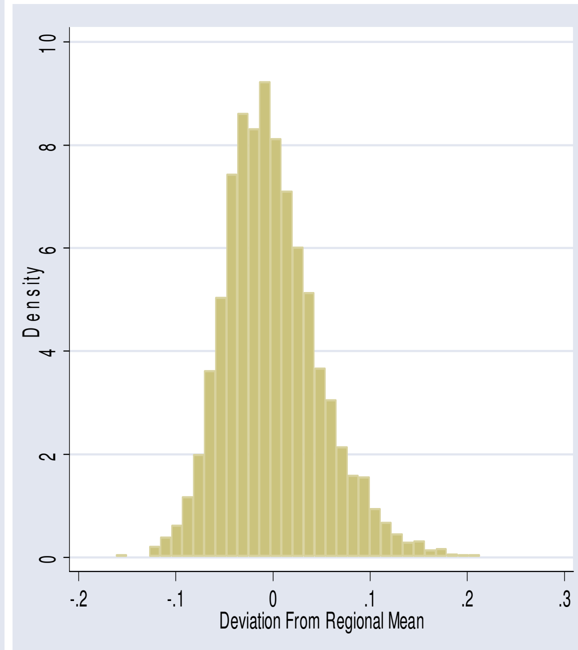


	Figure 2a	Figure 2b	Figure 2c
Standard: Deviation	6.0 percentage points	4.3 percentage points	4.9 percentage points

Note: an observation is the deviation between a physician's practice style and the regional average for a particular year. There are 848 physicians and 7,004 physician-years in the above figures. Physician practice styles are risk-adjusted based on patients' observed characteristics.