

A Longitudinal Analysis of the Impact of Liability Pressure on the Supply of Obstetrician-Gynecologists

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Conventional wisdom within the medical community suggests that dramatic increases in professional liability insurance premiums cause physicians to relocate or discontinue their practices in high-cost states. We employed a mixed-effects model to investigate the effect of malpractice risk, as measured by insurance premiums and various tort reforms, on the number of obstetrician-gynecologists (OB/GYNs) in the United States between 1992 and 2002. The longitudinal research design examines state-year-level data from all 50 states and the District of Columbia. We found that the supply of OB/GYNs had no statistically significant association with premiums or tort reforms. Our results suggest that most OB/GYNs do not respond to liability risk by relocating out of state or discontinuing their practice, and that tort reforms such as caps on noneconomic damages do not help states attract and retain high-risk specialists.

I. INTRODUCTION

Hospitals and physicians in many states have experienced considerable growth in medical professional liability insurance premiums over the past 15 years. Nationwide, malpractice premiums increased an average of 8.1 percent per year from 1992 to 2001, a rate of increase that is three times

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higher than that of general inflation and double that of medical inflation.¹ The steepest increases have come since 2000, at levels provoking the health-care and insurance communities to declare this period a “medical malpractice crisis.”²

Conventional wisdom within these communities suggests that physicians, particularly high-risk specialists, respond to dramatic premium increases by relocating or discontinuing their clinical practices—the most extreme manifestation of negative defensive medicine.³ Although multiple factors influence physician decisions about where to practice, the chief policy concern is that soaring medical malpractice premiums may cause shortages in the supply of physicians in some areas. Many anecdotal reports of these problems have surfaced in the policy debate over the malpractice crisis, prompting three waves of empirical research seeking more definitive data.⁴ The first wave was dominated by survey studies conducted by medical professional societies and other interest groups, which were generally of limited value due to poor response rates and response-bias issues. The second wave consisted of simple descriptive studies, many again commissioned by groups with a political axe to grind. The third wave has consisted of more carefully designed, controlled studies emanating from the academic community. Across and even within these groups of studies, findings concerning the relationship between malpractice pressure and physician supply have varied.⁵ Overall, clear evidence of a widespread diminution in overall physician supply has not been established.

¹Joint Economic Committee, U.S. Congress, *Liability for Medical Malpractice: Issues and Evidence* (Washington, DC, May 2003), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=659102.

²U.S. Department of Health & Human Services, *Addressing the New Health Care Crisis: Reforming the Medical Litigation System to Improve the Quality of Health Care* (Washington, DC, Mar. 2003), available at <http://aspe.hhs.gov/daltcp/reports/medliab.htm>; Congressional Budget Office, *Limiting Tort Liability for Medical Malpractice* (CBO, 2004), available at <http://www.cbo.gov/showdoc.cfm?index=4968&sequence=0>.

³D.M. Studdert, M.M. Mello, W.M. Sage et al., *Defensive Medicine Among High-Risk Specialist Physicians in a Volatile Malpractice Environment*, 293(21) *JAMA* 2609 (2005).

⁴M.M. Mello, *Medical Malpractice: Impact of the Crisis and Effect of State Tort Reforms* (Robert Wood Johnson Foundation, May 2006), available at http://www.rwjf.org/publications/synthesis/reports_and_briefs/issue10.html.

⁵*Id.*

This does not, however, necessarily imply an absence of supply problems for specific high-risk specialties. Because of the high economic and noneconomic damages primarily from “bad baby” cases involving severe neurological injuries to neonates, OB/GYNs are among the highest-risk specialists. For the years 1994 through 2000, the median indemnity payment in such cases was \$2,050,000, the highest for all types of medical liability cases.⁶ Malpractice claims against OB/GYNs account for a substantial share of total liability claims and payments;⁷ these specialists are sued, on average, 2.5 times during the course of their career;⁸ and average indemnity payments against them (\$399,658 in 2000) are the second-highest of any specialty, after neurologists.⁹

The frequency and severity of malpractice claims against obstetrical providers helps explain why the malpractice premiums they pay are consistently the highest or near-highest of all clinical specialties.¹⁰ However, there is significant variation in those premiums across states, with the highest rate more than 10 times the lowest.¹¹ In addition, the rate at which premiums for OB/GYNs have increased over time varies dramatically by geographic area.

A number of studies have investigated the link between malpractice risk and OB/GYN supply as part of more general analyses of physician supply. These studies have produced mixed results and are vulnerable to various methodological criticisms, as we discuss below. The conflicting findings and study limitations make further empirical analysis useful.

⁶T. Albert, *Liability Insurance Crisis: Bigger Awards Just One Factor*, Apr. 15 *Am. Med. News* (2002).

⁷General Accounting Office, *Medical Malpractice: Characteristics of Claims Closed in 1984* (Washington, DC, 1987), available at <http://archive.gao.gov/d2t4/132815.pdf>.

⁸S.L. Wilbourn, *ACOG Fellow Testifies in Senate on Need for Medical Liability Reform*, Feb. 11 *ACOG News Release* (2003), available at http://www.acog.org/from_home/publications/press_releases/nr02-11-03.cfm.

⁹C.B. Hammond, *Ob-Gyns and Patients Urge US Senate to Enact Medical Liability Reform*, Apr. 1 *ACOG News Release* (2003), available at http://www.acog.org/from_home/publications/press_releases/nr04-01-03.cfm.

¹⁰S.A. Norton, *The Malpractice Premium Costs of Obstetrics*, 34 *Inquiry* 62 (1997).

¹¹*Medical Liability Monitor*, 2003 Annual Rate Survey (Oct. 2003), available at <http://www.medicalliabilitymonitor.com/rate.html>.

In this article, we assess the impact of malpractice risk, as measured by malpractice premiums and various tort reforms, on two measures of physician supply adjusted for patient demand for obstetrical services: (1) the number of OB/GYNs per 10,000 births; and (2) the number of OB/GYNs per 100,000 child-bearing-aged women. We use a longitudinal research design to examine data from 51 jurisdictions over 11 years (1992–2002).

II. BACKGROUND

Controlled studies have used two measures of liability risk to examine associations with physician supply: premiums and tort reforms. Studies examining premiums have produced mixed findings. Gius used state-level data from 1994–1996 and found that “states with above-average medical malpractice insurance premiums have lower physician per-capita ratios.”¹² However, using state-level data from 1998–2002, Erus could not reproduce the effect.¹³

Gius’s analysis has been criticized for confining its study window to a period of relative calm in liability insurance markets.¹⁴ Erus’s model examines a more policy-relevant period, one in which changes in physician supply would be expected to be more in evidence, yet it did not identify an effect. Both studies considered physicians a homogeneous body, not investigating the possibility that some specialties may be more sensitive to changes in malpractice liability than others. If that is the case, then negative supply effects in some specialties may be canceled out or diluted by positive or no effects on other specialties, leading to null overall findings.

Grumbach and colleagues examined whether liability premiums led OB/GYNs and family practitioners to withdraw from medical practice in New York State between 1980 and 1989.¹⁵ They found no association between increases in malpractice insurance charges at the regional level and the

¹²M.P. Gius, *An Examination of the Determinants of Physicians Supply at the State Level*, 6 *J. Bus. Econ. Stud.* 73 (2000).

¹³B.B. Erus, *Malpractice Liability Crisis and Physician Location Choice* (Northwestern University Working Paper, 2004).

¹⁴*Supra* note 4.

¹⁵K. Grumbach, K. Vrazanian, D. Rennie & D.S. Luft, *Charges for Obstetric Liability Insurance and Discontinuation of Obstetric Practice in New York*, 44(1) *J. Fam. Prac.* 61 (1997).

discontinuation of medical practice in general or the withdrawal from obstetric practice in particular. However, the single-state setting of this study raises questions about its generalizability.

Baicker and Chandra analyzed four years of state-level data (1989, 1995, 2000, and 2001) on physician supply and found that changes in malpractice premiums did not significantly influence the overall size of the physician workforce.¹⁶ Young physicians and physicians approaching retirement age appeared to be slightly more responsive to rises in premiums than average, but the absolute magnitude of these responses was modest, and they did not consistently achieve statistical significance. Separately analyzing premiums from three medical specialties (internal medicine, general surgery, and OB/GYN) did not change the result. However, rural physicians were more sensitive than physicians in other locations to increases in malpractice premiums.

One limitation of the Baicker and Chandra study is that the authors' decision to average company-specific premium data without weighting the data to account for each company's market share may have resulted in biased estimates of overall premiums.¹⁷ Furthermore, the state-year fixed-effect estimation strategy could not examine both within-state and between-state variation. Finally, since relatively few covariates were included in the models, the estimates may suffer from omitted variable bias.

Studies using tort reforms as the main explanatory variables also have yielded mixed results. Kessler and colleagues examined the average impact of tort reforms on the number of physicians at the state level between 1985 and 2001.¹⁸ They divided liability-reducing malpractice reforms into those designed to directly reduce expected malpractice awards, such as damages caps, and those designed to reduce awards only indirectly. They found that physician supply increased 8.2 percent more rapidly in states that had adopted direct reforms compared to those with no reforms, and direct reforms tended to have a larger effect on the supply of specialties that faced relatively high malpractice insurance premiums. Curiously, however, states with indirect reforms, such as caps on attorney contingency fees and

¹⁶K. Baicker & A. Chandra, *The Effect of Malpractice Liability on the Delivery of Health Care*, in *Frontiers in Health Policy* (Cutler & Garber, eds., MIT Press, 2005).

¹⁷Supra note 4.

¹⁸D.P. Kessler, W.M. Sage & D.J. Becker, *Impact of Malpractice Reforms on the Supply of Physician Services*, 293 *JAMA* 2618 (2005).

modification of the joint and several liability rule, saw slower growth in physician supply than states with no reforms.

The Kessler study incorporated tort reforms into its multivariate analyses as two generalized dummy variables, direct reforms and indirect reforms. If a state had any of the four types of direct reforms in effect, the state was considered to have direct reforms in that year. Indirect reforms, which encompassed five different types of reforms, were defined in the same way. Such a specification does not permit a detailed understanding of the effect of particular reforms, limiting the practical policy value.

In contrast to Kessler's findings, Matsa, using county-level data, found that there was no statistically significant association between damages caps and overall physician supply. To test effect on rural counties in particular, he stratified counties into four groups according to their population and found that only those in the lowest quartile were affected by changes in the liability environment between 1970 and 2000.¹⁹ Damages caps increased physician supply by 3–5 percent for the most sparsely populated areas. The effect on specialists in these areas was even higher (10–12 percent). Matsa's analysis is well designed, but did group together all types of damages caps into a single dummy variable, precluding analysis of what type and level of cap had the strongest effect.

Klick and Stratmann, using state data from 1980–1998, found that states that had adopted a \$500,000 cap had 3 percent more physicians per 100,000 residents than states that did not have caps.²⁰ However, counterintuitively, a \$250,000 cap had no significant effect. This pair of results raises questions about the model specification.²¹ In a revised, stronger analysis using triple-differences estimation, the authors grouped all levels of noneconomic damages caps together.²² This analysis determined that the caps had a statistically significant positive effect on the number of physicians per

¹⁹D.A. Matsa, *Does Malpractice Liability Keep the Doctor Away? Evidence from Tort Reform Damage Caps* (Northwestern University Working Paper, 2006), available at (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=920846).

²⁰J. Klick & T. Stratmann, *Does Medical Malpractice Reform Help States Retain Physicians and Does it Matter?* (Working Paper, 2003).

²¹Supra note 4.

²²J. Klick & T. Stratmann, *Medical Malpractice Reform and Physicians in High Risk Specialties* (Working Paper, 2006).

capita in five specialties (neurosurgery, thoracic surgery, OB/GYN, general practice, and emergency medicine) in a state, increasing it by 6.1 percent. The decision to collapse the levels of caps was not explained and thus precludes inference about the relative effects of different types of caps.

Using four years of state-level data between 1985 and 2000, Hellinger and Encinosa found that states with caps on noneconomic damages had approximately 12 percent more physicians per capita than states without such a cap, though, as in the Kessler study, physician supply actually grew in both types of states.²³ The analysis did not control for other tort reforms and, once again, caps were considered monolithically.²⁴ In a separate study²⁵ using county-level data for eight years in the same period, these investigators found that counties subject to any damages cap (whether \$250,000 or higher) had 2 percent more physicians per capita than counties without caps (3 percent in rural counties). They also found that other state malpractice laws did not affect physician supply. Yet, the unpublished results showed, again counter-intuitively, that the \$250,000 cap was not significant while the higher cap was.²⁶ Furthermore, neither the first Klick and Stratmann study nor the state-level study by Hellinger and Encinosa examined heterogeneity among physicians.

Most of the tort reform studies described above employed a state-year fixed-effects method. This is statistically problematic because many states' tort reforms were time invariant during the study period. Fixed-effects coefficients take out the variation attributable to the mean for each state (the between-state variation), estimating the effect of reforms solely from the change over time within each state (the within-state variation). That is, fixed-effects models compare the average change in physician supply in the states that adopted (or abandoned) a reform with the average change in the rest of the states. If only a small number of states adopted (or abandoned) a tort reform over the study period, the "treatment" group in this comparison

²³F.J. Hellinger & W.E. Encinosa, *The Impact of State Laws Limiting Malpractice Awards on the Geographic Distribution of Physicians* (Agency for Healthcare Research and Quality, July 3, 2003), available at (<http://www.ahrq.gov/research/tortcaps/tortcaps.htm>).

²⁴Supra note 4.

²⁵W.E. Encinosa & F.J. Hellinger, *Have State Caps on Malpractice Awards Increased the Supply of Physicians?* *W5 Health Aff.* 250 (2005, Supp. web exclusive).

²⁶Supra note 4.

is small, raising two problems.²⁷ First, the precision of estimates may be low, which will be reflected in relatively large standard errors and lower significance levels. Second, there may be confounding by unobserved time-varying effects. The logic of the model is that such effects apply equally to the “treatment” and the control states, but as the number of states that adopted (or abandoned) reforms shrinks toward zero, the possibility that something different happened in the “treatment” states rises and the likelihood of confounding increases. For these reasons, fixed-effects models may not be the best choice for modeling the effects of tort reforms, at least over periods in which few states were adopting or jettisoning them.

The studies by Kessler and colleagues, Klick and Stratmann, and Hellinger and Encinosa used differences-in-differences estimation, which measures the difference in outcome over time for the treatment group compared to the difference in outcome over time for the control group.²⁸ Although these studies utilized serially correlated data, they do not appear to have performed corrections for the resulting inconsistency of standard errors, a critical concern with the differences-in-differences technique that has recently been described in detail.²⁹ The year-to-year correlations in physician supply mean that the standard errors estimated by this technique may grossly understate the standard deviation of the effects of estimated reforms, leading to overestimation of *t* statistics and significance levels.

Two other methodological limitations of existing studies warrant mention. First, virtually all studies of physician supply use the American Medical Association (AMA) Physician Masterfile³⁰ as the source of physician supply data, but do not account for possible reporting lags in that data set. Because key data fields in the Masterfile are based on a triennial physician survey, reporting lags are a major but underacknowledged shortcoming of

²⁷Personal communication with Dr. Joseph Newhouse, John D. MacArthur Professor of Health Policy and Management, Harvard University, Aug. 24, 2005.

²⁸J. H. Stock & M.W. Watson, *Introduction to Econometrics* (Addison Wesley, 2003).

²⁹M. Bertrand, E. Duflo & S. Mullainathan, How Much Should We Trust Differences-in-Differences Estimates? 119(1) *Q.J. Econ.* 249 (2004).

³⁰Medical Marketing Service, Inc., AMA Physician MasterFile (1994–2004), available at (<http://www.mmslists.com/main.asp>).

the Masterfile.³¹ For changes in physician practice, lags average two years.³² These lags are known to produce overestimates of physician supply and are a particular concern in longitudinal studies because they mean that the Masterfile has poor sensitivity in detecting physician retirements and relocations.³³

Second, virtually all previous studies have included medical residents and clinical fellows in their physician counts. Trainees are certainly part of the physician workforce and make important contributions to care delivery. However, compared to fully trained physicians, residents and fellows should have different response elasticity to their liability environment.³⁴ During early years of their residency training, they have relatively little freedom to relocate or discontinue their practice because they have made a multiyear commitment to their training program. At the end of their program, in contrast, they are highly mobile. Hence, it is not appropriate to lump residents in with practicing physicians when modeling physician responses to changes in the malpractice environment.

Taken together, these considerations suggest that research to date has not convincingly established what role, if any, liability pressure plays in determining the size of the physician workforce, particularly within individual physician specialties. In the present study, we address these issues by lagging physician supply data, excluding residents and fellows, incorporating premium data that are adjusted for market share and the number of physicians insured in each region of the state, and employing an estimation approach that accounts for both within- and between-state variations.

³¹L. Baldwin, W. Adamache, C.N. Klabunde et al., Linking Physician Characteristics and Medicare Claims Data: Issues in Data Availability, Quality, and Measurement, 40(8) *Med. Care* 85 (2002).

³²P.R. Kletke, Physician Workforce Data: When the Best is Not Good Enough, 39(5) *Health Serv. Res.* 1251 (2004).

³³Supra note 4.

³⁴M.M. Mello, D.M. Studdert, J. Schumi, T.A. Brennan & W.M. Sage, Changes in Physician Supply and Scope of Practice During a Malpractice Crisis: Evidence from Pennsylvania (Harvard School of Public Health Working Paper, 2006).

III. METHODS

A. *Conceptual Framework*

The conceptual framework for our analysis posits that the OB/GYN workforce in a particular state is influenced by various factors, among which are malpractice pressure, health-care market factors, and local socioeconomic characteristics. The main hypothesis is that malpractice pressure in a state, as measured by malpractice premiums and tort reforms, decreases the number of OB/GYNs per capita.

We separately model premiums and tort reforms as proxies for the overall intensity of malpractice pressure in a state. Malpractice premiums reflect the market's best judgment about future malpractice claims risk and, arguably, the best overall measure of malpractice pressure.³⁵ Specifically, they reflect the expected rate of claims (frequency), the average amount of payment per claim (severity), and the insurer's administrative costs and desired profit margin. Tort reforms aim to ease malpractice pressure by limiting damages awards, reducing the number of lawsuits, or making it more difficult for a plaintiff to prevail in a suit. Literature on tort reforms and defensive medicine suggests that physicians working in states that have enacted malpractice tort reforms will feel less malpractice pressure than physicians working in states without malpractice reforms.³⁶

We examined these two measures of malpractice pressure in separate models because they are not distinct constructs. Aside from a well-documented association between the two measures,³⁷ implementation of reforms is likely to be endogenous³⁸ to perceived market conditions related to premiums. In other words, reforms are likely implemented in response to rising medical malpractice insurance premiums. Including premiums and

³⁵S.M. Rock, *Malpractice Premiums and Primary Cesarean Section Rates in New York and Illinois*, 103 *Pub. Health Rep.* 459 (1988); A.R. Localio, A.G. Lawthers, J.M. Benqtson et al., *Relationship Between Malpractice Claims and Cesarean Delivery*, 269 *JAMA* 366 (1993).

³⁶D.P. Kessler & M. McClellan, *Do Doctors Practice Defensive Medicine?* 111 *Q.J. Econ.* 353 (1996).

³⁷K.E. Thorpe, *The Medical Malpractice "Crisis": Recent Trends and the Impact of State Tort Reforms*, W4 *Health Aff.* 20 (2004, Supp. Web Exclusive); D.P. Kessler & M. McClellan, *The Effects of Malpractice Pressure and Liability Reforms on Physicians' Perceptions of Medical Care*, 60(1&2) *Law & Contemp. Probs.* 81 (1997).

³⁸Supra note 28.

reforms as explanatory variables in the same model risks collinearity problems and complicates interpretation, since their endogeneity makes it difficult to conceive of a regression coefficient as the effect of one while holding the other constant.

Therefore, we ran two sets of regressions with slightly different aims: the premiums model most directly tests the extent of liability pressure on the supply of OB/GYNs, while the tort reform model answers the policy question of which reforms are most effective in attracting and retaining OB/GYNs. Finally, anticipating that all covariates included in our study would affect physician workforce with a lag, we lagged the covariate data by one year.

B. Empirical Model

Several considerations supported the use of a mixed model to examine our panel data set. First, tort reforms were largely time invariant in many states over the study period, rendering a fixed-effects model less appropriate. Second, dummy variables created by fixed-effects models can consume many degrees of freedom. Third, fixed-effects models take out the between-state variation, which was of interest in our study. Finally, Hausman tests verified the appropriateness of a random-effects specification ($p > 0.16$ for all models).

The mixed model, an extension of the traditional random model, contains both fixed and random components.³⁹ The fixed components, which are estimated directly, are analogous to standard regression coefficients.⁴⁰ The random components are not directly estimated, but are characterized by variance and covariance estimates. The data structure may consist of multiple levels of nested groups. In longitudinal data, each time series constitutes an individual cluster. Observations between levels or clusters are independent, but observations within each cluster are dependent because they belong to the same subpopulation.

Mixed models produce statistically efficient estimates of fixed regression coefficients. Specifically, they adjust for autocorrelation and heteroscedasticity via covariance structures, and allow a more appropriate and realistic

³⁹H. Goldstein, *Multilevel Statistical Models*, 2d ed. (Edward Arnold, 1995); E.W. Frees, *Longitudinal and Panel Data: Analysis and Applications in the Social Sciences* (Cambridge University Press, 2004).

⁴⁰P.J. Diggle, P. Heagarty, K.Y. Liang & S. Zeger, *Analysis of Longitudinal Data*, 2d ed. (Oxford University Press, 2002).

specification of complex variance structures at each level. Moreover, mixed models not only use within-subject variation over time, but also quantify between-subject variation in the time trajectory of dependent variables.

Our panel data are a series of 11 repeated measures of OB/GYN supply for each of the 50 states and the District of Columbia, and we use the state-year as the unit of analysis. In this data set, the residuals from neighboring states are likely to be spatially correlated. Commonalities of medical practice, lifestyle preferences, health-care market characteristics, and liability environments may contribute to this dynamic.⁴¹ Standard inference procedures involving panel data assume that the cross-sectional units are independent and violation of this assumption can lead to inconsistent estimates of standard errors. To account for the possibility of correlations among jurisdictions, we calculate standard errors assuming a third level to the data structure, that of U.S. Census Bureau region.

Using vector and matrix notation, our model can be expressed as:

$$Y_{ijk} = X_{ijk}\beta + Z_{ijk}^{(3)}u_k^{(3)} + Z_{ijk}^{(2)}u_{jk}^{(2)} + \varepsilon_{ijk},$$

where Y_{ijk} is the supply of OB/GYNs per capita in year i , state j , and region k . X_{ijk} is a design matrix for fixed effects β . It includes time-trend variables and two groups of explanatory variables: health-care market and socioeconomic factors. Instead of creating a dummy variable for each year, we describe the patterns of change in the mean responses over time in terms of simple polynomial trends. $Z_{ijk}^{(3)}$ is a design matrix for region random effects $u_k^{(3)}$; $Z_{ijk}^{(2)}$ is a design matrix for state random effects $u_{jk}^{(2)}$; and ε_{ijk} is a vector of errors.

C. Data

The main data set used in the study is the AMA Physician Masterfile for 1994–2004. The Masterfile contains information on all allopathic physicians and many osteopathic physicians in the United States; it is not limited to AMA members. A variety of sources are used to update the Masterfile, including information from medical schools, hospitals, state licensing agencies, medical societies, and professional associations. In addition, the AMA

⁴¹J.P. Driscoll & A. Kraay, Spatial Correlations in Panel Data (World Bank Policy Research Working Paper No. 1553, Dec. 1995), available at (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=604938).

conducts a triennial survey of the entire physician population to collect detailed practice information.⁴²

For new physicians, the AMA updates the Masterfile by creating data records. Reporting lags for this type of update are relatively rare. The AMA tracks medical students training in U.S. medical schools and posts their information in the Masterfile at the time of their graduation. New international medical graduates are posted in the Masterfile when they enter residency training. These updates are made with information from the Annual Survey of Graduate Medical Education Programs, which collects data on virtually all physicians in residency and fellowship training programs.⁴³

On the other hand, reporting lags are common for changes in the practices of fully qualified physicians, such as whether physicians provide direct patient care, whether they are still professionally active, and where their practice is located. As discussed above, reliance on a triennial physician survey creates lags in reported data on physician attrition from clinical practice or migration to new practice locations. Despite this problem, the Masterfile is the most complete and authoritative source of national data on physician supply.

D. Dependent Variables

Previous studies of the effect of liability pressure on OB/GYN supply have generally used the ratio of OB/GYNs to general population as the dependent variable. We use two outcome variables that incorporate a more precise adjustment for demand for obstetrical services: (1) the number of OB/GYNs per 10,000 births and (2) the number of OB/GYNs per 100,000 women of child-bearing age (15–44 years old).

Data on the number of OB/GYNs in each state were extracted from the Masterfile. We excluded OB/GYNs not involved in patient care, residents, and fellows. These exclusions yield a sample of fully qualified OB/GYN physicians who are active in patient care in each state. We lagged the Masterfile data by two years to account for the reporting lag problem. Thus, to investigate the “exposure” period 1992–2002, we analyzed Masterfile data from 1994–2004. Data on birth counts by state over the study period were

⁴²T. Pasko, B. Seidman & S. Birkhead, *Physician Characteristics and Distribution in the U.S.* (American Medical Association, 2000–2001).

⁴³American Medical Association, *Surveys and Data Resources*, available at <http://www.ama-assn.org/ama/pub/category/2674.html>.

extracted from the Natality Detail File (NDF).⁴⁴ Data on state populations of women of child-bearing age were acquired from the U.S. Census Bureau.

E. Main Explanatory Variables

1. Premiums

We used data on OB/GYN malpractice premiums from an annual survey conducted by the Medical Liability Monitor (MLM).⁴⁵ Every year since 1991, the MLM has conducted a nationwide survey of physician malpractice insurance premiums for policies insuring a physician against a single loss of up to \$1 million and up to \$3 million in total losses in a policy year. In a few cases, this \$1 million/\$3 million coverage is not available, in which case the MLM reports premiums for the policies offered. Reporting to the MLM is voluntary for insurers.

For each state in a given year, the MLM separately reports multiple companies' premiums. However, the MLM does not collect market share information for those insurers. Rather than calculating simple averages of those premiums, as other studies have done,⁴⁶ we weighted them according to the market shares of the reporting insurers. State-level market share data were obtained from the National Association of Insurance Commissioners (NAIC) database.⁴⁷ These data showed that the MLM collected premium information from carriers that insured approximately 45 percent of OB/GYNs, on average, across all states during our study period. MLM data from the early 1990s are less complete than more recent data, but we have no reason to believe that missing premium data otherwise differ substantially from the available premiums.

⁴⁴National Center for Health Statistics, Natality Detail File (Hyattsville, Md., 1991–2002).

⁴⁵Medical Liability Monitor, Annual Rate Survey (1991–2002), available at (<http://www.mlmonitor.com/rate.html>).

⁴⁶K.E. Thorpe, The Medical Malpractice “Crisis”: Recent Trends and the Impact of State Tort Reforms, *W4 Health Aff.* 20 (2004, Supp. Web Exclusive); R. Quinn, Medical Malpractice Insurance: The Reputation Effect and Defensive Medicine, 65(3) *J. Risk Ins.* 467 (1998); P.M. Danzon, A.J. Epstein & S. Johnson, The “Crisis” in Medical Malpractice Insurance 56–96 (Brookings-Wharton Papers on Financial Services, 2004).

⁴⁷National Association of Insurance Commissioners, Market Share Reports for Groups and Companies: Medical Malpractice (1993–2004).

MLM premium data from about 35 percent of the jurisdictions are broken down within state for different geographic regions—typically, counties or large metropolitan areas. For these states, in addition to adjusting for market share, we computed a physician-weighted average state premium, using AMA data on the distribution of physicians.⁴⁸ This two-stage weighting process produced notable improvements in the accuracy of the premium data relative to simple averages. For example, the simple average OB/GYN malpractice premium in Colorado in 2002 is \$43,489, versus a weighted average of \$32,863.

Eight states have established patient compensation funds, which provide insurance coverage for malpractice awards and settlements that exceed the limits of the primary-layer insurance policy.⁴⁹ States finance the funds through provider surcharges. Surcharges paid by OB/GYNs in these states were incorporated into our premium measure, using data from the MLM (for recent years) and the relevant state authorities (for earlier years). Our final premium data are composed of weighted OB/GYN premiums by state for 1991–2002, adjusted to real 2002 dollars using the GDP deflator.⁵⁰

2. Tort Reforms

Information about state tort reforms was gathered from the National Conference of State Legislatures (NCSL),⁵¹ the American Tort Reform Association (ATRA),⁵² and a law firm website.⁵³ Although many of the tort reforms were adopted between 1983 and 1988 as a response to the malpractice crisis

⁴⁸American Medical Association, *Physician Characteristics and Distribution in the US* (American Medical Association, 1993–2004).

⁴⁹F.A. Sloan, C.A. Mathews, C.J. Conover & W.M. Sage, *Public Medical Malpractice Insurance: An Analysis of State-Operated Patient Compensation Funds*, 54 *DePaul L. Rev.* 247 (2005).

⁵⁰NASA, *GDP Inflation Calculator*, available at <http://www1.jsc.nasa.gov/bu2/inflateGDP.html>.

⁵¹National Conference of State Legislatures, *Medical Liability/Medical Malpractice*, available at <http://www.ncsl.org/programs/health/medmalmain.htm>.

⁵²American Tort Reform Association, *State and Federal Reforms*, available at <http://www.atra.org/reforms>.

⁵³McCullough, Campbell & Lane LLP, *Medical Malpractice Summary Index of States*, available at <http://www.mcandl.com/states.html>.

of the early 1980s,⁵⁴ a number of reforms were implemented during the study period.

Previous studies have taken a range of approaches to modeling the effect of tort reforms. Some have developed scales to rank various tort reforms in order of perceived stringency or efficacy. For example, Waters and colleagues rated reforms on a scale of 1 (least likely to discourage medical malpractice cases) to 7 (most likely to discourage them).⁵⁵ Such scales tend to be quite subjective, particularly given the paucity of empirical evidence about the efficacy of many reforms. Other researchers have created an index variable reflecting the number of reforms in each state in a given year.⁵⁶ However, because some tort reforms (such as damages caps) have been shown to have more impact than others,⁵⁷ treating them as a continuous variable—that is, making the assumption that each unit increase in the number of reforms produces a constant change in the dependent variable—cannot be justified.

For these reasons, our approach was to include separate dummy variables for each reform: attorney fee limits, collateral source rule, damage caps, expert witness rule, joint and several liability rule, periodic payment of awards, and pretrial screening. (Because almost all states had some form of statute of limitations, we did not attempt to model that reform.) These reforms can be grouped into three basic families: damages reform, limitations on access to court, and modification of liability rules.⁵⁸ Caps on damages were further split into four groups: those limiting punitive damage awards, those capping noneconomic damage awards at \$250,000, those capping noneconomic damage awards at between \$250,000 and \$500,000,

⁵⁴F.A. Sloan & R.R. Bovbjerg, *Effects of Tort Reforms on the Value of Closed Medical Malpractice Claims: A Microanalysis*, 14 *J. Health Pol. Pol'y & L.* 663 (1989).

⁵⁵T.M. Waters, D.M. Studdert, T.A. Brennan et al., *Impact of the National Practitioner Data Bank on Resolution of Malpractice Claims*, 40(3) *Inquiry* 283 (2003).

⁵⁶P. Brace, H. Tankersley & J. Yates, *Do Institutions Really Matter? Assessing the Impact of State Judicial Structures on Citizen Litigiousness* (1st Annual Conference on Empirical Legal Studies Working Paper), available at (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=799306).

⁵⁷K.E. Thorpe, *The Medical Malpractice "Crisis": Recent Trends and the Impact of State Tort Reforms*, W4 *Health Aff.* 20 (2004, Supp. Web Exclusive).

⁵⁸D.M. Studdert, M.M. Mello & T.A. Brennan, *Medical Malpractice*, 350 *New Eng. J. Med.* 283 (2004).

and those capping noneconomic or total damage awards at greater than \$500,000. These categories were constructed so as to account for the fact that some states adjust their cap amount annually for inflation. For example, an inflation-adjustable cap originally set at \$400,000 was treated as a \$250,000–500,000 cap until the year in which its nominal value exceeded \$500,000, at which time it was shifted to the greater-than-\$500,000 category.

The effects of tort reforms on the liability environment are believed to occur with a lag.⁵⁹ The lag is due, at least in part, to insurers' unwillingness to reduce premiums until several months of claims data are available upon which actuaries can base post-reform-era premiums. Insurer hesitance to adjust premiums is compounded by any uncertainties that exist in the state about whether specific tort reforms will survive constitutional challenge.⁶⁰ To account for such effects, we lagged tort reform data by one year. Each tort reform variable was set equal to 1 for the year following implementation and all subsequent years, unless the reform was held unconstitutional, in which case it reverted to 0 in the year of the ruling.

F. Other Explanatory Variables

1. Health-Care Market Factors

In general, physicians are more likely to practice in the state where they trained than in any other state.⁶¹ Additionally, areas with a large number of residency slots tend to be areas with relatively high demand for physician services (e.g., large urban areas). These factors suggest that the number of OB/GYN trainees per capita a state has may be an important independent predictor of the number of fully qualified OB/GYNs per capita in that state. Therefore, our models include a covariate indicating OB/GYN residents and fellows per capita (general population) in each state, using data from the Masterfile.

⁵⁹S. Zuckerman, S. Norton & B. Wadler, A State-Based Survey of Malpractice Premiums: Implications for Medicare Physician Payment Policy (Urban Institute Working Paper 6090-02, 1992); see also *supra* note 36.

⁶⁰S. Zuckerman, R.R. Bovbjerg & F. Sloan, Effects of Tort Reforms and Other Factors on Medical Malpractice Insurance Premiums, 47 *Inquiry* 167 (1990).

⁶¹American Association of Neurology, Medical School and Training, available at (<http://www.aan.com/students/medical/training.cfm>).

Empirical evidence has shown that HMO penetration is associated with lower growth over time in the number of medical and surgical specialists and total physicians; faster HMO growth has also been linked to larger increases in the proportion of generalist physicians.⁶² The spread of managed care also appears to heighten the probability of early retirement among older physicians.⁶³ For these reasons, we included a variable indicating HMO penetration in each state, using data from Interstudy.⁶⁴

For most clinical specialties, including obstetrics, physician supply is related to the number of hospital beds per capita because additional beds create additional demand for physicians to attend to patients.⁶⁵ Therefore, we included a covariate indicating the number of hospital beds per capita in each state, using data from the American Hospital Association (AHA).⁶⁶

Economic theory and some empirical evidence suggest that physician supply will be greater in states with higher physician income.⁶⁷ However, neither physician income nor OB/GYN income were available at the state level for our study period. Therefore, we used general per-capita income as a proxy.⁶⁸ Values were adjusted to real 2002 dollars using the Consumer Price

⁶²J.J. Escarce, D. Polsky, G.D. Wozniak & P.R. Kletke, HMO Growth and the Geographical Distribution of Generalist and Specialist Physicians, 35(4) *Health Serv. Res.* 825 (2000); J.J. Escarce, D. Polsky, G.D. Wozniak, M.V. Pauly & P.R. Kletke, Health Maintenance Organization Penetration and the Practice Location Choices of New Physicians: A Study of Large Metropolitan Areas in the United States, 36(11) *Med. Care* 1555 (1998); D. Polsky, P.R. Kletke, G.D. Wozniak & J.J. Escarce, HMO Penetration and the Geographic Mobility of Practicing Physicians, 19(5) *J. Health Econ.* 793 (2000).

⁶³P.R. Kletke, D. Polsky, G.D. Wozniak & J.J. Escarce, The Effect of HMO Penetration on Physician Retirement, 35(5) *Health Serv. Res.* 17 (2000).

⁶⁴Morgan Quitno Press, *Health Care State Rankings, 1993–2004* (Morgan Quitno Press, 1993–2004).

⁶⁵Supra note 12.

⁶⁶American Hospital Association, *Hospital Statistics* (American Hospital Association, 1993–2004).

⁶⁷Supra note 12.

⁶⁸U.S. Bureau of Economic Analysis, *Regional Economic Accounts*, available at (<http://www.bea.gov/region/statelocal.htm>).

Index.⁶⁹ In addition, hypothesizing that premiums may affect physicians more when their income is lower, we explored potential interaction effects between premiums and per-capita income.

2. Socioeconomic Factors

Socioeconomic factors may be related to physician location decisions insofar as they reflect quality-of-life considerations, the demand for obstetrical/gynecological care, or the available reimbursement for patient care. Because patients with lower socioeconomic status generally have less ability to access and pay for medical services, we included a variable measuring the percentage of the state's births to minority mothers, derived from the NDF. This measure is imperfect, but reflects the established correlation between ethnic minority status and lower socioeconomic status.⁷⁰ We also controlled for the mix of insurance types (employment based, Medicaid, or no insurance) among state residents. Data on insurance status of the state population were obtained from the U.S. Census Bureau for 1992–2002.⁷¹ The variable for employment-based insurance was dropped from the models due to collinearity with other insurance variables.

Rurality of a state or region tends to be negatively related to the supply of physicians, even at the per-capita level.⁷² We therefore used Census data to construct a variable that captured the percentage of the state's population living in metropolitan areas.⁷³ To investigate the possibility that the effect of premiums on physician supply may increase with the degree of rurality, we examined interactions of premiums and rurality. Finally, the cost of living may influence physician location choice, so our model included a variable

⁶⁹U.S. Bureau of Labor Statistics, CPI Inflation Calculator, available at (<http://data.bls.gov/cgi-bin/cpicalc.pl>).

⁷⁰L.F. Berkman & I. Kawachi, *Social Epidemiology* (Oxford University Press, 2000).

⁷¹U.S. Census Bureau, Health Insurance Coverage Status and Type of Coverage by State—All Persons: 1987 to 2004, available at (<http://www.census.gov/hhes/www/hlthins/historic/hihist4.html>).

⁷²T.C. Ricketts, Workforce Issues in Rural Areas: A Focus on Policy Equity, 95(1) *Am. J. Pub. Health* 42 (2005).

⁷³U.S. Census Bureau, About Metropolitan and Micropolitan Statistical Areas, available at (<http://www.census.gov/population/www/estimates/aboutmetro.html>).

for the state-specific cost-of-living index, which we acquired from the *Congressional Quarterly*.⁷⁴

G. Model Diagnostics

Outliers were identified using the Hadi method, which identifies multiple outliers in multivariate data.⁷⁵ We performed regressions with and without outliers and found that the regression results were not significantly different. Normality of residuals was tested using the Shapiro-Wilk W test. For each outcome variable, $p > 0.05$, indicating that we cannot reject the hypothesis that the outcome variable is normally distributed. Multicollinearity was examined by using the variance inflation factor (VIF). VIF values greater than 10 merit further investigation, but none of the VIF values in our models were greater than 7. Issues of serial correlation and heteroskedasticity were adjusted for or modeled via the covariance structures of our mixed models. Finally, the model specification (which was the same for the premium models and the tort reform models) was checked using the Ramsey regression specification error test.⁷⁶ For each model, $p > 0.05$, indicating that we cannot reject the hypothesis that there is no statistically significant specification error.

IV. RESULTS

A. Descriptive Results

Table 1 summarizes the variables used in our analyses. On average, there were 80.9 OB/GYNs per 10,000 births and 51.4 OB/GYNs per 100,000 women of child-bearing age during the study period.

Nationwide, the number of OB/GYNs per 10,000 births and per 100,000 women of child-bearing age increased between 1992 and 2002 (Figures 1 and 2). In bivariate analyses, both outcome variables were positively correlated with OB/GYN malpractice premiums (Pearson coefficients

⁷⁴Congressional Quarterly Press, CQ's State Fact Finder: Rankings Across America (CQ Press, 1993–2004).

⁷⁵Stata Corp, Stata Help for Hadimvo, available at (<http://www.stata.com/help.cgi?hadimvo>); A.S. Hadi & J.S. Simonoff, Procedures for the Identification of Multiple Outliers in Linear Models, 88 *J. Am. Stat. Assoc.* 1264 (1993).

⁷⁶J. Ramsey, Tests for Specification Errors in Classical Linear Least Squares Regression Analysis, 32 *J. Royal Stat. Soc'y Bull.* 350 (1969).

Table 1: Descriptive Statistics ($N = 561$)

<i>Variables</i>	<i>Mean</i>	<i>SD</i>
Outcome Variables		
The number of OB/GYNs per 10,000 births	80.86	21.63
The number of OB/GYNs per 100,000 child-bearing-aged women	51.43	14.67
Explanatory Variables		
OB/GYN malpractice premiums (\$10,000)	4.23	1.84
Health-care market factors		
Per-capita OB/GYN residents and fellows (per 100,000)	7.10	5.44
Per-capita hospital beds (per 1,000)	3.49	1.12
HMO penetration (%)	18.11	12.63
Per-capita income (\$10,000)	2.73	0.45
Socioeconomic Factors		
Insurance status (%)		
Employment-based insurance	71.31	6.52
Medicaid	16.27	4.65
No insurance	12.42	3.73
Nonwhite births (%)	20.02	14.84
Cost-of-living adjustment	88.78	11.49
Percent of population in metropolitan areas	68.35	21.30

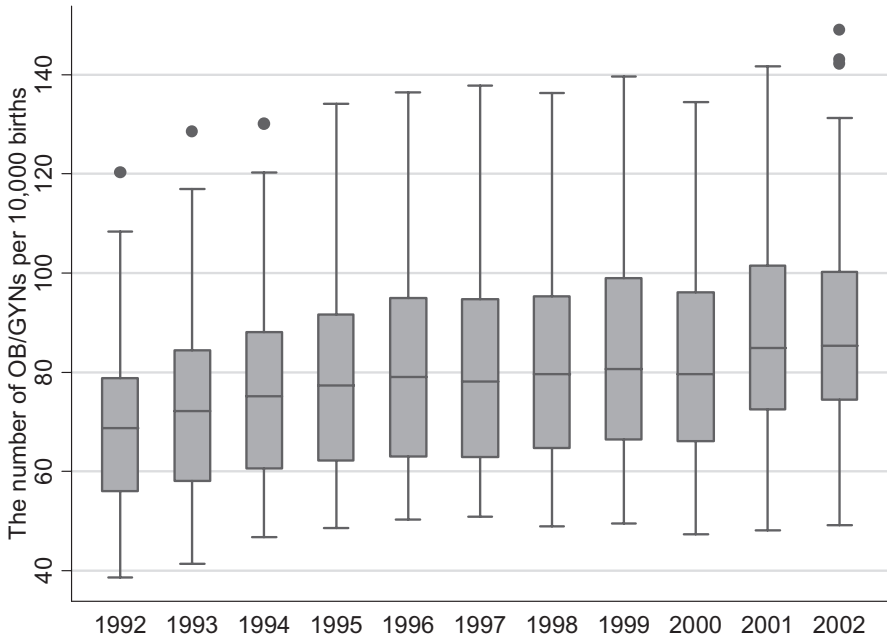
of 0.22 and 0.21, respectively). The unexpected direction of this relationship suggests the importance of multivariate analysis to control for possible confounders.

A curvilinear trend was observed for malpractice premiums nationwide (Figure 3). In general, premiums during the mid-1990s were lower than those during the early 1990s and early 2000s. In addition, interstate variations in premiums appear to have increased over time. Figure 4 presents OB/GYN premiums by state in 2002, grouped into five categories. Some regional correlation is apparent.

B. Effects of Malpractice Premiums on OB/GYN Supply

Neither the number of OB/GYNs per 10,000 births nor the number of OB/GYNs per 100,000 women of child-bearing age was significantly associated with malpractice premium levels (Table 2). The regression analysis reversed the positive correlations observed in bivariate analysis, but the associations did not achieve statistical significance ($p = 0.76$ for births model and $p = 0.60$ for women model). Overall, the results provide no evidence that liability pressure, as measured by malpractice premiums, is associated with the supply of OB/GYNs per capita in a state.

Figure 1: Trends in OB/GYNs-to-births ratio.



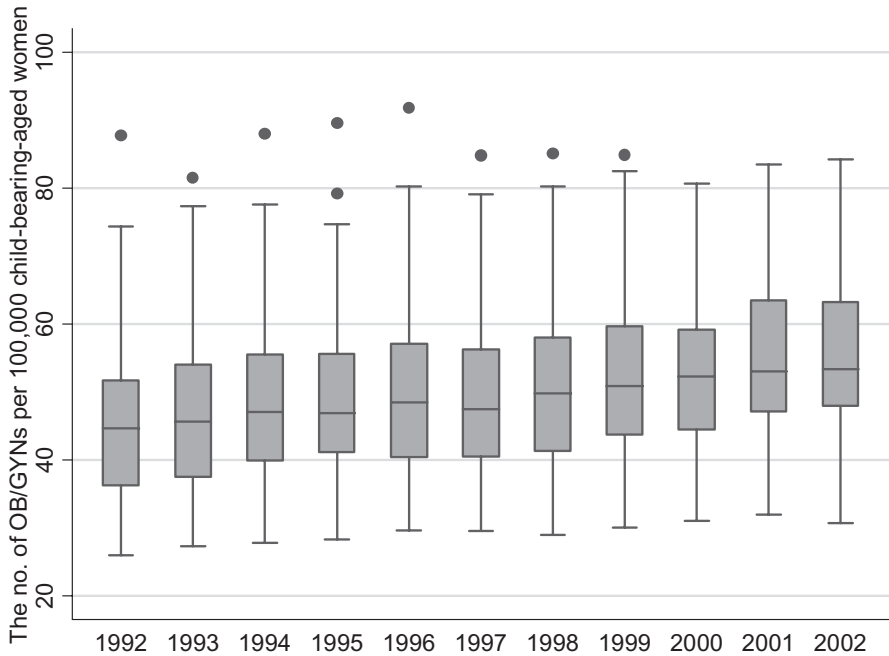
NOTE: In box-and-whisker plots, the central box represents values from the 25th to 75th percentile of the distribution and the horizontal line in the middle of the box represents the median. The vertical lines that extend from the boxes show minimum and maximum values, excluding “outside values,” which are displayed as separate points. An outside value is defined as a value that is larger than the upper quartile plus 1.5 times the interquartile range, or smaller than the lower quartile minus 1.5 times the interquartile range.

The main drivers of the number of OB/GYNs per capita in our model was the number of OB/GYN trainees, per-capita income, per-capita hospital beds, and the percent of population living in metropolitan areas. HMO penetration, measures of low socioeconomic status, and interaction terms were not statistically significant.

C. Effects of Tort Reforms on OB/GYN Supply

In multivariate analysis, none of the tort reform variables was statistically significant at the 95 percent confidence level (Table 3). Neither were they jointly significant ($p > 0.58$). The results for the other independent variables were generally in line with the findings from the premium models.

Figure 2: Trends in OB/GYNs-to-child-bearing-aged-women ratio.



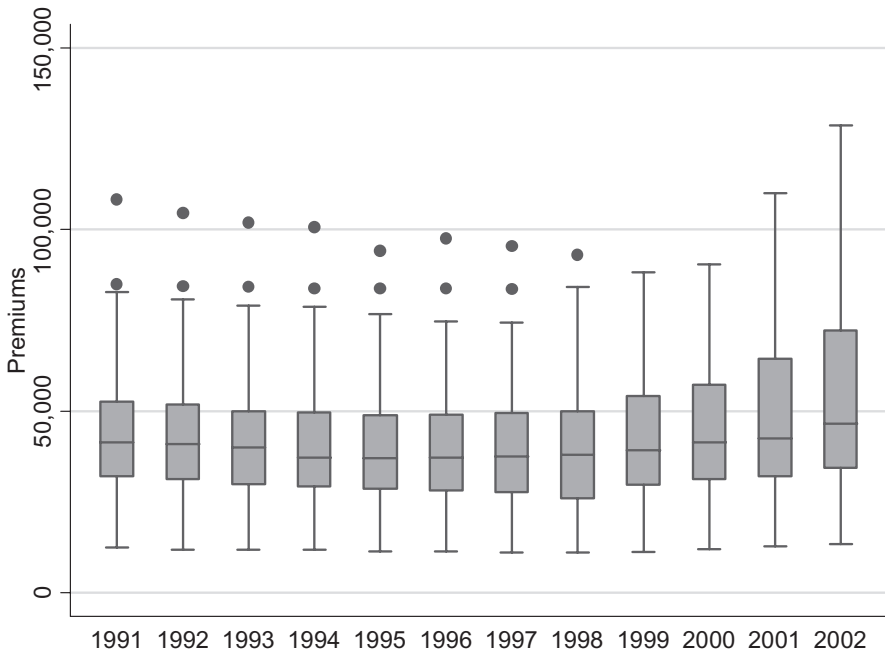
D. Sensitivity Analyses

We performed two sensitivity analyses designed to probe possible measurement error in the model. First, instead of using per-capita income as a proxy for OB/GYN income, we reran the models with state-specific average OB/GYN wage data. We obtained these data from the Bureau of Labor Statistics, but did not use them in the main model because they were available only for the period 1999–2002.⁷⁷ (Hence, this particular sensitivity analysis was confined to those four years.) Second, we reran the tort reform models lagging the reform variables by three years instead of one, to account for the possibility of longer reaction times on the part of insurers.

We performed two additional sensitivity analyses designed to test the robustness of our findings by limiting the sample in ways that maximized the likelihood of detecting an effect of liability risk on physician supply. We

⁷⁷U.S. Bureau of Labor Statistics, Occupational Employment and Wage Estimates: State Cross-Industry Estimates, available at (http://www.bls.gov/oes/oes_dl.htm).

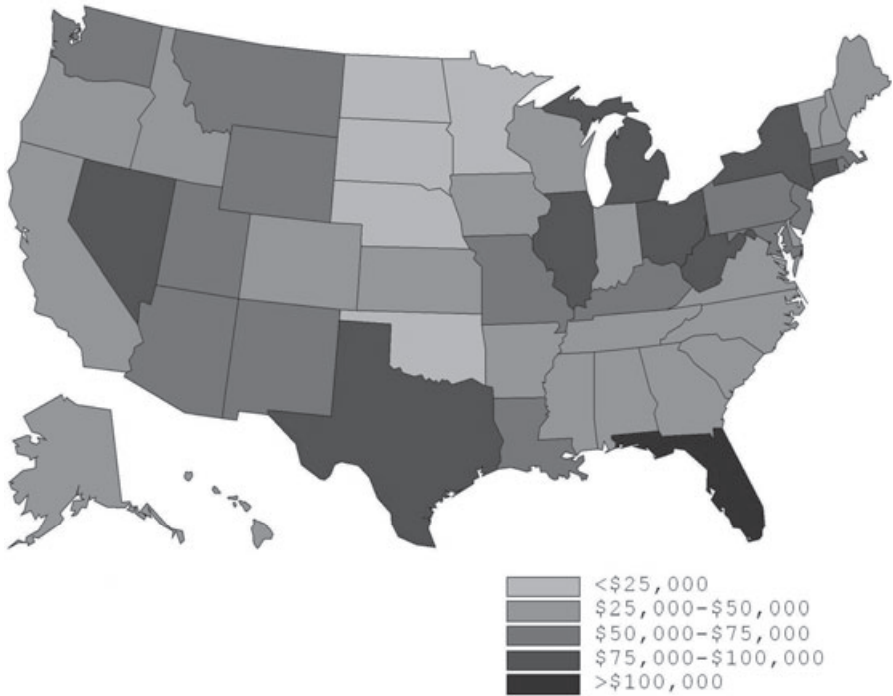
Figure 3: Average annual malpractice insurance premiums for obstetrician-gynecologists.



tested for supply effects within two age groups (<35 years and >55 years) of physicians that would be expected to have greater-than-average mobility and thus greater elasticity to changes in the liability environment. Newly qualified physicians and physicians nearing retirement age would theoretically be more willing and able to enter and exit practice in a particular state than middle-aged physicians, who would have established practices and stronger personal ties to an area but would not have the financial means or inclination to retire. We also reran the analyses after confining the data set to the nine states in which OB/GYN malpractice premiums grew more than 45 percent from 1999–2002 (Pennsylvania, Arkansas, Ohio, Oregon, Texas, Montana, Florida, New Mexico, and Virginia) and the nine states in which OB/GYN malpractice premiums grew less than 5 percent over the same period (Minnesota, Wisconsin, California, Colorado, Hawaii, Arizona, Oklahoma, Alabama, and Alaska).

None of these reanalyses changed the core findings from the original analysis: neither the premium nor the tort reform models showed a statisti-

Figure 4: Malpractice insurance premiums for obstetrician-gynecologists in 2002, by state.



cally significant correlation between the malpractice environment and number of OB/GYNs per capita. Detailed results are available, on request, in a technical appendix.

V. DISCUSSION

Our results, consistent across every version of the analytic model, suggest that malpractice insurance premium levels and the presence of liability-limiting tort reforms in a state do not significantly affect the supply of OB/GYNs at the state level. These results are at odds with assertions of an exodus of OB/GYNs from states with high and rapidly rising insurance premiums. They also undercut suggestions that caps on noneconomic damages and other tort reforms help states attract and retain high-risk specialists by providing relatively good insulation from malpractice judgments.

Table 2: Multivariate Regression Results—Impact of Premiums on the Number of OB/GYNs per 10,000 Births and per 100,000 Child-Bearing-Aged Women (*N* = 561)

	<i>OB/GYNs-to-Births Ratio</i>		<i>OB/GYNs-to-Child-Bearing-Aged Women Ratio</i>	
	β	p	β	p
OB/GYN premiums (\$10,000)	-0.15	0.76	-0.13	0.60
Health-care market factors				
Per-capita OB/GYN residents and fellows (per 100,000)	0.88	<0.01	0.47	<0.01
Per-capita hospital beds (per 1,000)	1.87	0.04	4.36	<0.01
HMO penetration (%)	-0.07	0.13	-0.04	0.14
Per-capita income (\$10,000)	3.84	0.01	4.31	<0.01
Socioeconomic factors				
Insurance status (%)				
Medicaid	-0.06	0.59	-0.04	0.50
No insurance	-0.10	0.39	-0.02	0.69
Nonwhite births (%)	-0.02	0.13	<-0.01	0.08
Cost-of-living adjustment	0.11	0.11	0.07	0.07
Percent of population in metropolitan areas	0.23	<0.01	0.26	<0.01
Linear time trend	1.31	<0.01	1.04	<0.01

NOTE: Longitudinal mixed-effects models were used to investigate the effect of malpractice premiums on the two outcome variables from all 50 states and the District of Columbia and between 1992 and 2002.

The findings are largely consistent with the overall picture traced by the strongest prior studies, which is that the malpractice climate has had trivial or no effects on physician supply.⁷⁸ They differ from the conclusion reached by Kessler and colleagues, who found a small but statistically significant relationship between several tort reforms and growth in physician supply.⁷⁹ That study’s focus on overall physician supply, rather than OB/GYNs, may explain the discrepancy. Additionally, Kessler and colleagues did not adjust for serial correlation across residuals within states and consequently may have overestimated the statistical significance of regression coefficients.⁸⁰

⁷⁸Supra note 4.

⁷⁹Supra note 18.

⁸⁰Supra note 29.

Table 3: Multivariate Regression Results—Impact of Tort Reforms on the Number of OB/GYNs per 10,000 Births and per 100,000 Child-Bearing-Aged Women ($N = 561$)

	<i>OB/GYNs-to-Births Ratio</i>		<i>OB/GYNs-to-Child-Bearing-Aged Women Ratio</i>	
	β	p	β	p
Tort Reforms				
Attorney fee limits	0.65	0.42	1.07	0.49
Collateral source rule	0.29	0.78	0.11	0.93
Caps on damages				
Punitive only	0.88	0.54	1.19	0.19
Noneconomic \leq \$250,000	1.43	0.18	1.62	0.13
Noneconomic \$250,001–500,000	0.27	0.19	0.96	0.14
Noneconomic or total $>$ \$500,000	0.03	0.19	0.67	0.20
Periodic payment	0.05	0.54	0.16	0.64
Expert witness rule	0.42	0.46	1.05	0.34
Joint and several liability rule modified	-0.67	0.49	-0.03	0.99
Pretrial screening	0.05	0.41	0.07	0.62
Health-Care Market Factors				
Per-capita OB/GYN residents and fellows (per 100,000)	0.96	<0.01	0.59	<0.01
Per-capita hospital beds (per 1,000)	1.61	0.05	3.65	0.02
HMO penetration (%)	-0.15	0.29	-0.18	0.33
Per-capita income (\$10,000)	3.56	0.02	4.19	0.01
Socioeconomic Factors				
Insurance status (%)				
Medicaid	-0.17	0.53	-0.14	0.58
No insurance	-0.06	0.37	-0.02	0.66
Nonwhite births (%)	-0.11	0.21	-0.09	0.13
Cost-of-living adjustment	0.18	0.22	0.15	0.12
Percent of population in metropolitan areas	0.25	0.01	0.27	0.01
Linear time trend	1.42	<0.01	1.21	<0.01

NOTE: Longitudinal mixed-effects models were used to test the effect of various tort reforms on the two outcome variables from all 50 states and the District of Columbia and between 1992 and 2002. After the regression, a joint tort reform test was performed to examine whether the tort reform variables were collectively significant. The results indicated that they were jointly insignificant. (Model of OB/GYNs-to-births ratio: the tort reform variable’s p value was 0.63; model of OB/GYNs-to-child-bearing-aged women ratio: the tort reform variable’s p value was 0.58.)

A. Possible Explanations for Findings

Aside from methodological issues, there are at least five possible explanations for our finding that liability risk is not reflected in changes in the state-level supply of OB/GYNs.

- Alternative 1: Premium increases are not substantial enough, as a proportion of physician practice expenses, to constitute a significant threat to physician income.
- Alternative 2: Premium increases constitute a significant economic burden, threatening physician income, but physicians can pass most of rising premiums on to third-party payers.
- Alternative 3: Premium increases do significantly affect physician income, but physicians continue practicing in their present location because the costs associated with relocating or switching to another profession are prohibitive.
- Alternative 4: Physicians are relocating in response to premium increases, but relocations are primarily within state, and thus unobservable in our analysis.
- Alternative 5: Physician practice decisions are not primarily motivated by a desire to maximize income.

The first four explanations assume that physician decisions to stop or continue providing patient care at their current locations represent the outcome of a rational calculation to maximize utility, and that net income is the major component of their utility. The fifth explanation is that such an assumption is mistaken. We briefly consider each of these possibilities in the subsections below.

1. Alternative 1: Premium Increases Are Not Significant Enough to Threaten Physician Income

Rodwin and colleagues, analyzing AMA survey data from 1970 to 2000, found that increasing premiums between 1996 and 2000 had little impact on total practice expenses or net practice income nationally, and that malpractice premiums have long been a small part of overall practice costs.⁸¹ Premiums rose from 6 percent of total practice expenses in 1970 to 11 percent in 1986, but then fell back to 7 percent by 2000. These trends held in all regions and for high-risk specialties, including OB/GYNs. The authors argued that increased premiums after 2000 continued to have a “negligible effect” on total practice costs. This analysis suggests that the income effect of premium increases would be too small to cause physicians to close or move their practices.

⁸¹M. Rodwin, H.J. Chang & J. Clausen, Malpractice Premiums and Physicians’ Income: Perceptions of a Crisis Conflict with Empirical Evidence, 25(3) *Health Aff.* 750 (2006).

The Rodwin study may be of limited applicability to our findings because the period they examined does not extend across the recent malpractice crisis. The weighted 2002 Florida OB/GYN premium in our analysis is above \$100,000, which is not negligible, although it may still be small in relation to total practice expenses. The Medicare Economic Index, a national measure of the cost of providing medical care, reveals that malpractice premiums accounted for only 3.87 percent of practice expenses nationally in 2000⁸² and less than 5 percent in 2005.⁸³ These percentages are in the aggregate, and premiums may still be significant relative to total practice expenses for any given physician. Nevertheless, this explanation may at least partially account for many physicians' insensitivity to premium increases.

2. Alternative 2: Physicians Can Pass on Rising Premiums to Other Payers

Analyzing physician group practice data, Pauly recently determined that higher malpractice premiums did not lower physician net incomes in 1994–2002.⁸⁴ Instead, physicians offset the income effect of higher premiums by increasing the volume of profitable medical services they provided and, sometimes, by increasing prices. In other words, physicians appear to be able to recoup increased insurance costs by billing health insurers for more services and/or charging more. A recent study by the Center for Studying Health System Change lends further support for this thesis. Analyzing data from 1995–2003, the study found that physicians had begun to “order more revenue-generating diagnostic test procedures” to address decreased incomes (which may in part have been attributable to rising malpractice costs).⁸⁵ If physicians' net incomes are largely insulated from malpractice

⁸²Centers for Medicare and Medicaid Services, Medicare Economic Index, available at (<http://www.cms.hhs.gov/MedicareProgramRatesStats/downloads/mktbskt-economic-index.pdf>).

⁸³Medicare Payment Advisory Committee, *A Data Book: Healthcare Spending and the Medicare Program* (June 2005), available at (http://www.medpac.gov/publications/congressional_reports/Jun05DataBook_Entire_report.pdf).

⁸⁴M.V. Pauly, *Who Pays When Malpractice Premiums Rise?* In *Medical Malpractice and the U.S. Health Care System* (W.M. Sage & R. Kersh, eds., Cambridge University Press, 2006); M.V. Pauly, C. Thompson, T. Abbott, J. Margolis & W. Sage, *Who Pays? The Incidence of High Malpractice Premiums* (Working Paper, 2006).

⁸⁵H.T. Tu & P.B. Ginsburg, *Losing Ground: Physician Income, 1995–2003* (Center for Studying Health System Change Tracking Report No. 15. June 2006), available at (<http://www.hschange.com/CONTENT/851/>).

costs, then the potential for tort reforms—even reforms that are very effective in restraining the growth of insurance premiums—to affect physician practice decisions will be quite limited.

3. Alternative 3: Transaction Costs of Relocation or Career Change Are Prohibitive

The costs of moving an established medical practice are substantial and may be prohibitive for many physicians. These costs include the monetary expense of moving; the opportunity cost of income forgone while moving, setting up practice, and rebuilding a professional reputation in the new location; and the psychic costs of leaving friends and relatives, uprooting family, and adjusting to a new community. Hence, established physicians who have developed strong ties to their present location are likely to have a high level of geographic immobility.⁸⁶ Even if rising premiums significantly affect their income, those increases may remain lower than the perceived costs of moving. Staying put, but switching from patient care to another set of professional activities, may also be costly or simply infeasible given local opportunities. To the best of our knowledge, there are no published accounts of average costs related to physician relocation. However, this phenomenon of economic “stickiness” is a very plausible contributing factor to our findings.

4. Alternative 4: Relocations Were Unobservable in a State-Level Analysis

Although variations in the malpractice environment are most pronounced at the state level, insurance premium levels may diverge considerably by geographic region within a state. For example, the MLM reported that Ohio OB/GYNs paid \$99,761 per annum in 2002 if they were located in Cleveland, \$63,105 in Columbus, and \$46,400 in Cincinnati.⁸⁷ With this level of within-state variation, it is possible that premium increases prompted physicians to move to areas with more affordable coverage, but that these relocations were mainly to other regions within the state. These moves would not have been detected in our analysis. A county-level analysis should reveal such shifts. However, the well-designed study by Matsa found very little evidence of such

⁸⁶D. Polsky, P.R. Kletke, G.D. Wozniak & J.J. Escarce, HMO Penetration and the Geographic Mobility of Practicing Physicians, 19(5) *J. Health Econ.* 793 (2000).

⁸⁷Supra note 11.

effects. Overall, within-state effects are not the most persuasive explanation for our findings.

5. Alternative 5: Physicians Do Not Seek to Maximize Income

Each of the above four explanations is based on the assumption that physicians are utility maximizers and define utility primarily by reference to net income. They would not hold if physicians, as a group, do not seek to maximize income. It is possible that physicians simply endure premium hikes and continue to serve patients out of a sense of professional duty. We find this explanation somewhat implausible, however. Many analyses have documented physicians' income-maximizing tendencies.⁸⁸ For example, in the face of Medicare reimbursement controls, physicians increased their income by increasing the quantity and intensity of services they provided to Medicare enrollees.⁸⁹ The findings from these and other studies suggest that physicians, as a group, generally seek to maximize or at least maintain income.

Overall, the first three explanations collectively provide a theoretical basis and some empirical support for why rising premiums do not appear to drive physicians away from a particular state, and why tort reforms are not a significant attraction.

B. Study Limitations

Our study examines changes in OB/GYN supply. Although we found that supply was inelastic to malpractice pressure, and adjusted for measures of demand for obstetrical services, our results do not necessarily imply that access to high-risk obstetrical services was unaffected. The number of practicing obstetricians per capita is an imperfect measure of access; more sensitive measures include patient travel times and wait times for obstetrical

⁸⁸T.G. McGuire & M.V. Pauly, Physician Response to Fee Changes with Multiple Payers, 10(4) *J. Health Econ.* 385 (1991); J. Thornton & B.K. Eakin, The Utility Maximizing Self-Employed Physician, 32(1) *J. Hum. Res.* 98 (1997); J.A. Rizzo & D. Blumenthal, Physician Labor Supply: Do Income Effects Matter? 13(4) *J. Health Econ.* 433 (1994).

⁸⁹W.C. Yip, Physician Response to Medicare Fee Reductions: Changes in the Volume of Coronary Artery Bypass Graft (CABG) Surgeries in the Medicare and Private Sectors, 17(6) *J. Health Econ.* 675 (1998); J.M. Mitchell, J. Hadley & D.J. Gaskin, Physicians' Responses to Medicare Fee Schedule Reductions, 38(10) *Med. Care* 1029 (2000); N.X. Nguyen & F.W. Derrick, Physician Behavioral Response to a Medicare Price Reduction, 32(3) *Health Serv. Res.* 283 (1997).

services and the number of patients who must switch obstetricians or have difficulty finding an obstetrician. It is possible that rising premiums or lack of tort reform negatively impacted these dimensions of access without changing overall supply.

One pathway would be through reduced scope of practice. Anecdotal reports of OB/GYNs who have ceased practicing obstetrics out of liability concerns but continue to provide gynecological care are one example of such a restriction; another is OB/GYNs who perform normal deliveries but not high-risk deliveries.⁹⁰ To the extent that these shifts occurred, our results would underestimate the impact of medical liability risk on the supply of obstetric *services* (as distinct from the supply of OB/GYN *physicians*). However, a recent study of one state experiencing severe malpractice insurance costs, Pennsylvania, did not find restrictions in scope of practice to be widespread among OB/GYNs.⁹¹

Another pathway would be through changes in the overall quantity of services each OB/GYN supplies. Physicians might decrease the number of hours spent on patient care or decrease their productivity in response to malpractice pressure. Although there is some evidence of such effects,⁹² the study by Pauly suggests the opposite—that physicians increase the volume of services provided when insurance costs rise.

Our study has other limitations. We focused on the short-term effects of changes in the malpractice environment on the number of OB/GYNs per capita, but there may also be longer-term effects. For example, deterioration in the liability environment may dissuade medical students from entering obstetrics/gynecology, disrupting the pipeline of future OB/GYNs.⁹³

Additionally, as previously noted, our state-level analysis could not assess the influence of malpractice liability risk at a more detailed geographic level. Finally, data limitations precluded us from testing some potential

⁹⁰American College of Obstetricians & Gynecologists, Medical Liability Survey Reaffirms More OB-GYNs Are Quitting Obstetrics (July 16, 2004), available at http://www.acog.org/from_home/publications/press_releases/nr07-16-04.cfm.

⁹¹Supra note 34.

⁹²E. Helland & M.H. Showalter, The Impact of Liability on the Physician Labor Market (Working Paper, 2006), available at <http://www.law.uchicago.edu/files/conf/malpractice/helland.pdf>; D.P. Kessler & M.B. McClellan, How Liability Law Affects Medical Productivity, 21(6) J. Health Econ. 931 (2002).

⁹³Supra note 4.

predictors of OB/GYN supply; for example, we lacked information on state-specific OB/GYN practice expenses and reimbursement rates for obstetrical/gynecological services.

VI. CONCLUSION

Although the costs of malpractice insurance are substantial for OB/GYNs, they do not appear to be significantly associated with the supply of OB/GYNs in a state. Most practitioners in this specialty do not respond to liability risk by relocating or discontinuing their practice. However, it is possible that they modify their behavior in more subtle ways that affect access to care. Additional study of effects on the scope of practice, the number of hours each physician spends in patient care, and physician productivity is warranted. These factors are important determinants of patient access to care, and definitive statements about the impact of malpractice pressure on supply and access depend on consideration of both the number of practicing physicians and the constellation of services they actually provide.

