Criminal Prosecution and Physician Supply

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Abstract

While there are many evidences of the effect of medical malpractice tort, research on the effect of medical malpractice criminal sanctions are rare. This paper tries to identify the causal effect of criminal prosecution utilizing exogenous variations over the likelihood of criminal prosecution. In 2004, a medical accident occurred in Fukushima prefecture, Japan and an obstetrician was prosecuted one year after. This prosecution exogenously changed the likelihood of criminal prosecution in Fukushima prefecture. Using synthetic control approach, we estimate the causal effect of criminal prosecution. The prosecution decreased the number of obstetricians by 13% and some of them changed their business to gynecology, which involves lower risk. However, the effect is concentrated on obstetricians, not all physicians. While the relatively weak estimates of tort liability in the literature might suggest strengthening the present sanctions, we need to be cautious about such policy. In addition, the paper shows that the sentence of acquittal did not resolve the effect caused by the initial prosecution. This illuminates the importance of criminal prosecution itself and its social sanctions, not subsequent criminal sanctions. It also highlights the importance of risk perception of physicians.

Keywords: Medical malpractice, physician supply, criminal prosecution, social sanction, risk perception.

JEL Classification: I18, K14.

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1 Introduction

Motivation The number of physicians is an important factor in determining the quality of our health care environment. While medical malpractice tort and criminal sanctions against medical malpractice are intended to incentivize improvement of the quality of medical care service, they also influence the supply of physicians at the same time.

There exists a huge literature that analyzes the effects of medical malpractice tort on deterrence and physician supply. However, empirical evidence on the effect of medical malpractice criminal law is scarce. While there exist variations among US states over medical malpractice tort, such as damages caps, abolition of punitive damages, joint-and-several liability reform, and patient compensation funds, there does not exist clear-cut variation over medical malpractice criminal law. In addition, criminal prosecutions of medical accidents are quite rare, which makes it difficult to identify the causal effect of criminal prosecution on physicians' behavior.

At the same time, the relatively weak estimates in the current literature cause some to doubt whether influences of medical malpractice tort are meaningful determinants of physician behavior (Frakes (2015)). Strengthening tort sanctions, including imprisonment in extreme cases, could be a policy agenda in such an environment, particularly in the political arena. In order to predict what would happen if we strengthened the present tort sanctions, observing the effect of criminal sanction on physician behavior can provide a clue to such issue.

Outside of the US, most countries have a single unified jurisdiction and do not have variations of medical malpractice tort nor criminal law. Unlike the US, we usually cannot use variations of tort law within a single country. However, the likelihood of criminal prosecution can vary within a single country. We study the effect of temporary exogenous change of likelihood of criminal prosecution on physician supply.

In late 2004, a pregnant mother died after delivery in Fukushima prefecture, Japan. Almost a year later, the prosecutors at Fukushima District Court brought a negligent

homicide charge against an obstetrician who operated on her at delivery. This prosecution changed the perceived likelihood of criminal prosecution in Fukushima prefecture temporarily. Since prosecutors are randomly assigned to each district court in Japan, the unexpected increase of the likelihood of criminal prosecution in Fukushima prefecture was an exogenous shock and occurred only in Fukushima prefecture. We use this change of likelihood as exogenous variations to study the causal effect of criminal prosecution.

In order to identify the causal effect of criminal prosecution, we first constructed a panel dataset by collecting prefecture-by-prefecture data of Japan. The Ministry of Health, Labour and Welfare (MHLW) publishes surveys on a number of physicians every two years. We combined this data with demographic and economic variables and constructed a panel dataset that covers the period before and after the criminal prosecution.

We then employed a synthetic control research design, where Fukushima prefecture is the treatment prefecture and other prefectures are the control prefectures. We found that the criminal prosecution decreased the number of physicians in Fukushima prefecture who specialize in obstetrics by 13%. [1] Some of them moved out of the prefecture, while 70% of them changed their business from obstetrics to gynecology, [2] where the risk of medical malpractice is much lower.

We also found that the causal effect of criminal prosecution did not go away after the Fukushima District Court delivered a judgment of acquittal. This implies that criminal prosecution itself, rather than the expectation of criminal sanctions alone, has a significant deterrent effect. This effect is supposedly caused by social sanctions caused by criminal prosecution. Another possible explanation is that the criminal prosecution has changed the risk perception of physicians in the treatment jurisdiction. Criminal law is a sharp knife. When tort law is already in place as a tool of deterrence, we need to employ

[1] Compared to Matsa (2007), which reports that the damages cap on medical malpractice tort increased physician supply by 10-12%, the effect of criminal prosecution is economically significant.

[2] Note that most obstetricians in Japan practice gynecology at the same time. The number of 'pure' obstetricians, who do not practice gynecology, is quite small in Japan.

criminal law cautiously.

Literature Review There is considerable empirical evidence on the impact of medical malpractice tort law. [3] Kessler and McClellan (1996, 2002) investigate whether medical malpractice tort reforms affected medical practices ("defensive practice"). Sloan and Shadle (2009) examine whether malpractice tort reforms had any effect on medical expenses and Lakdawalla and Seabury (2011) also investigated the impact of medical malpractice tort on social welfare. More directly concerned with the deterrent effect of medical malpractice tort, Frakes and Jena (2014), and Zabinski and Black (2014) examine whether medical malpractice reforms influenced health care quality. Matsa (2007) is closely related with this paper, as it tries to estimate the effect of damage caps on physician supply.

Turning to research on obstetricians, who face one of the highest rates of malpractice lawsuits among medical specialties, Currie and MacLeod (2008) investigate whether specific tort reforms affect the types of procedures that are performed, and the health outcomes of mothers and their infants. Kim (2007) also examines whether malpractice risk alters the procedure choices of obstetricians. Frakes (2012) follows the same track, estimating the relationship between malpractice tort law and decisions faced by obstetricians. More directly related to the deterrent effect, Yang et al (2012) and Iizuka (2013) investigate the effect of medical malpractice tort on health outcomes.

The most closely related research to this paper is Klick and Stratmann (2007). They argue that many doctors are likely to be indifferent regarding medical malpractice tort reform, because their likelihood of being sued is low. They exploit this difference to isolate the causal effect of medical malpractice reform on the supply of doctors in high-risk specialties, by using doctors in low-risk specialties as a within-state control group. They examine whether medical malpractice tort reforms have any impact on physician supply.

At the same time, our estimates are relatively large compared to the existing litera-

[3] Kachalia and Mello (2011) review what is known about the effectiveness of various strategies for liability reform and the implications for the future direction of reform.

ture on civil sanctions. Our results imply that strengthening the present civil sanctions could have serious negative effects on physician behavior and that we need to be cautious about increasing the present civil sanctions on medical malpractice beyond a certain extreme.

In addition, our paper is related to the literature on the deterrent effect of criminal law. Starting from Becker (1968), the literature has discussed how criminal sanctions and their enforcement (probability of sanction) have a deterrent effect on criminal behavior; the empirical side of the literature has identified many factors which are related to the deterrent effect. This paper tries to separately estimate the effect of criminal prosecution and final judgment, thereby identifying the causal effect of prosecution itself.

This paper proceeds as follows. Section 2 describes the circumstances surrounding obstetrics in Japan and the criminal prosecution we examine. Section 3 describes our data and section 4 discusses empirical strategies for identification. Section 5 presents the results of our analysis and section 6 discusses the implications and limitations of our analysis.

2 Background: Obstetricians in Japan

2.1 National Trends

Obstetrics has long been known as one of the toughest working environments for physicians. Delivery involves many risks and obstetricians are inevitably exposed to injuries, disorders, and even a certain probability of deaths of patients, although the probability is not so high. The high-risk profile of obstetrics leads to a high likelihood of medical malpractice lawsuits, which deters physicians from entering into the field.

As fewer and fewer physicians are becoming obstetricians, the working environment of obstetricians is becoming more severe. Smaller number of obstetricians increases the workload of each obstetrician and the ensuing overwork can be another cause of medical accidents, which then decreases the entrance of physicians into obstetrics. There is a negative spiral in the number of obstetricians and their working environment. Figure 1

shows the national trend in the number of physicians.

As Figure 1 indicates, while the number of total physicians (right y-axis) is increasing steadily, the number of physicians who specialize in obstetrics, gynecology, and obstetrics and gynecology (left y-axis) is relatively stable. This trend implies that the ratio of obstetricians are decreasing in spite of the governmental effort to increase obstetricians. [4]

The negative spiral can be observed in a recent survey of physicians. MedPeer, Inc., which operates a social networking service for physicians in Japan, conducted a survey through its SNS (March 2, 2015). [5] The survey asks each physician whether the supply of obstetricians is sufficient in her local business area. Among the 4,083 respondents, 49.4% repliedthat the supply of obstetricians is not sufficient and 6.1% assert that the situation is critical.

In such an environment, criminal prosecutions of physicians and medical malpractice tort lawsuits are expected to have serious effects on the supply of physicians. For example, MedPeer, Inc. conducted another survey on criminal prosecution of physicians (May 7, 2015). [6] Among 3,820 respondents, over 90% replied that they fear criminal prosecution. Many of them considered that social sanctions, such as loss of jobs and social stigma through criminal prosecution and associated media coverage, are the most serious concerns. The number of respondents (46.4%) who valued social sanctions as the most significant effect of criminal prosecution is six times larger than that of respondents (7.2%) who valued criminal punishment as the most significant effect. Because physicians regard acquittal as not restoring the damages caused by criminal prosecution, they fear criminal prosecution itself much more than criminal punishment.

[4] For example, the Ministry of Health, Labour and Welfare introduced obstetric compensation system for cerebral palsy in 2009. This system is intended to resolve the negative spiral surrounding obstetricians. See http://www.sanka-hp.jcqhc.or.jp/documents/english/pdf/bira english color201407.pdf

[5] https://medpeer.co.jp/press/ cms dir/wp-content/uploads/2015/03/Posting 20150302.pdf

[6] https://medpeer.co.jp/press/ cms dir/wp-content/uploads/2015/05/Posting 20150507.pdf

2.2 The Ono Hospital Case

Fukushima Prefectural Ono Hospital [7] was located on the coastal area of Fukushima prefecture. [8] On December 17, 2004, the delivery of a young pregnant mother was being udertaken. It was known beforehand that she had placenta previa and the obstetrician had informed her that her delivery was a high-risk case. Although the obstetrician advised her to move to a larger hospital, she refused to move in order to save on hospital costs. In addition, she required the obstetrician not to hysterectomize because she wanted one more child.

Around 2:30 pm, she delivered a baby by Cesarian section, but the obstetrician found some difficulty in detaching her placenta. Finally the obstetrician managed to detach the placenta and there was a bleeding of 2,000ml. Around three o'clock, the amount of bleeding reached 7,600ml and her blood pressure fell. Despite various attempts to save her life, the mother died around seven o'clock. The final amount of bleeding was 19,475ml. The cause of her death was complications of placenta accreta and placenta previa. [9]

Although the obstetrician and the hospital thought that he had not committed medical malpractice and did not report as accidental death to the police, Fukushima prefecture organized an accident investigation board. In March 2005, the board published a report, which identified the death as having been caused by several errors of the obstetrician. It is said that Fukushima prefecture, which was running Ono Hospital, sought to facilitate payment from medical liability insurance by admitting negligence. [10]

[7] Ono Hospital has been shut down since March 2011. It was hit by 2011 Great East Japan Earthquake and its location was near the Fukushima Dai-ichi Nuclear Power Plant.

[8] The description of the Ono Hospital Case relies on the case documents of the criminal case. For an overview of the case, see Idegawa (2009).

[9] The rate of occurrence of placenta accreta and placenta previa is 0.01% and 0.5%, respectively. However, when the existence of placenta previa is already known, the rate of occurrence of placenta accreta increases to 5-10%.

[10] The liability insurance Fukushima prefecture (and the Ono Hospital) had purchased was a liability insurance. A typical medical malpractice liability insurance policy only covers liabilities of an insured (physician) against third parties. When the insured is not negligent, she does not assume any liability against third parties and there is no payment of insurance claim. In contrast,

The publication of the report fired media criticism at the obstetrician, which pushed the police and the prosecutors to take action. On February 18, 2006, the police arrested the obstetrician and, on March 10, the prosecutors brought charges against him. The Japan Society of Obstetrics and Gynecology, and Japan Association of Obstetricians and Gynecologists published press releases and argued that placenta accreta is almost impossible to diagnose beforehand and to treat effectively, and that the arrest and the criminal prosecution was grossly inappropriate. [11]

Although there had been several criminal prosecutions of medical malpractice prior to the Ono Hospital Case, all of the former cases involved intentional crime or obvious errors of physicians and hospitals, such as medication errors, misidentification of patients, grossly negligent wrong diagnoses, and reckless operations. [12] The Ono Hospital Case was unique in that a standard medical treatment became a target of criminal charge, which invoked strong disapprovals from physicians.

In other words, the prosecution can be seen as a wrong decision driven by media pressure. It demonstrated that the prosecutors in Fukushima prefecture were vulnerable to media pressure and prone to mistaken prosecutions. It is plausible that many physicians doing business in Fukushima prefecture at the time feared that the risk that they would be wrongly prosecuted had increased suddenly.

However, the Fukushima District Court delivered a sentence of acquittal on August 20, 2008. [13] The court argued that the obstetrician followed standard medical practice

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when she is negligent, she assumes liability against third parties and the insurance policy covers her loss.

[11]The Japan Society of Obstetrics and Gynecology's press releases are:

`http://www.jsog.or.jp/news/html/announce 10MAR2006.html`
`http://www.jsog.or.jp/news/html/announce 17MAY2006.html`

Japan Association of Obstetricians and Gynecologists's press releases are:

`http://www.jaog.or.jp/sep2012/News/2006/06Mar10.pdf`
`http://www.jaog.or.jp/sep2012/News/2006/06May17.pdf`

[12]See Kai (2012) pp. 9-15.

[13]*Kikan Keiji Bengo* vol. 57 p.185.

and that he was not negligent. The prosecutors gave up on appealing the case and the sentence of acquittal became the final and conclusive judgment.

The obstetrician was suspended from work after the criminal prosecution. He returned to work after the sentence of acquittal, but soon moved to another private hospital. [14] The criminal prosecution imposed serious damages on him and the acquittal could not restore the damage thoroughly.

3 Data

3.1 Data

In order to estimate the causal effect of criminal prosecution of physicians, we used the number of physicians as the dependent variable. The Ministry of Health, Labour and Welfare (MHLW) has conducted a survey of physicians, dentists and pharmacists every two year since 1982. [15] The purpose of this survey is to identify the distribution of physicians, dentists, and pharmacists by sex, age, type of practice, place of work, and clinical specialty. The data is available online from the 1996 survey through to the 2012 survey. [16] From the survey, we extracted the prefecture-by-prefecture numbers of total physicians, obstetricians, gynecologists, and 'obstetrician-gynecologists'. [17] As most physicians specializes not only in obstetrics but also in gynecology in Japan, it is reasonable to observe the number of physicians who specialize in both obstetrics and gynecology ('obstetrician-gynecologists'). Although the survey changed the categories of clinical specialty from 2008, the change was minor one and does not affect the categories for obstetricians, gynecologists, and obstetrician-gynecologists.

However, we need to be careful about the 2012 data since the 2012 data is heavily influenced by the 2011 Great Earthquake. The Great Earthquake hit the east of Japan severely

[14] http://www.47news.jp/CN/200810/CN2008100101000206.html

[15] http://www.mhlw.go.jp/english/database/db-hss/spdp.html

[16] http://www.e-stat.go.jp/SG1/estat/NewList.do?tid=000001030962

[17] Unfortunately, the 1996 data only provides the prefecture-by-prefecture numbers of physicians per 100,000 population. We estimated the actual number by multiplying the prefecture population.

and Fukushima prefecture also suffered from the damages of the Fukushima Dai-ichi Nuclear Power Plant accident. The number of physicians in Fukushima prefecture has dramatically decreased since March 2011. The 2012 data would contaminate the causal effect of criminal prosecution.

With respect to the demographic and economic data of each prefecture, Statistics Bureau at the Ministry of Internal Affairs and Communications publishes the System of Social and Demographic Statistics of Japan (SSDSJ). [18] From this system, we first collected population data including the child (age of 0-14) population, and the population of females of childbearing age (age of 15-49) by each prefecture. We also obtained the number of reported pregnancies, the number of hospitals, and the number of hospital beds. Second, we collected the economic features of each prefecture. Gross prefectural product (GPP: prefectural version of GNP) and per capita prefectural income (PI: prefectural version of NI) data are available only from 2001 to 2010. In addition, we acquired the consumer price index (CPI) for medical care expenses from 1996 to 2008.

3.2 Summary Statistics

By combining the data sources, we constructed a strictly balanced panel dataset of 47 prefectures ($N = 47$) from 1996 to 2012 ($T = 9$). Table 1 shows the summary statistics of the data.

Table 1 reveals an interesting feature of obstetricians in Japan. While the number of physicians per prefecture who specialize in both obstetrics and gynecology (obstetrician-gynecologists) is large (mean = 228), the number of physicians per prefecture who specialize only in obstetrics is quite small (mean = 14.6). This implies that most obstetricians in Japan practice gynecology at the same time, as we mentioned before.

Thus in order to estimate the causal effect of criminal prosecution, it is not sufficient to observe the number of obstetricians alone. The number of physicians who specialize in both obstetrics and gynecology is should be the focus. In addition, we need to sum up

[18] http://www.stat.go.jp/english/data/ssds/outline.htm

these two numbers in order to observe the effect on the total number of physicians who specialize in obstetrics.

4 Empirical Strategy

4.1 Difference-in-Differences

The simplest way to identify the causal effect of the Ono Hospital Case is to employ the difference-in-differences (DiD) technique. While it is true that Japan as a whole consists of a single jurisdiction and the impact of the Ono Hospital Case could spill over the whole nation, each prosecutor has considerable discretion over whether she builds a case for the court. The fact that the prosecutors in Fukushima prefecture subsequently brought charges against the obstetrician in the Ono Hospital Case might only affect the physicians working in Fukushima prefecture. Physicians working outside of the prefecture might consider that the prosecutors in their own prefectures are not as stupid (or hostile) as their counterparts in Fukushima prefecture.

Therefore it is reasonable to assume that Fukushima prefecture is the treatment jurisdiction and other prefectures belong to the control jurisdiction. The possibility of a spillover effect implies that the DiD estimates of the Ono Hospital Case are the lower bounds of its causal effect, because the national trend caused by the spillover effect is subtracted from the true causal effect.

In addition, we can safely assume that the treatment is an exogenous shock. Whether a medical malpractice case is classified under criminal prosecution or not basically depends on the severity of the physician's negligence. The severity of negligence has a random nature and does not correlate with the aggregate number of physicians at prefecture level. There can be other minor factors involved, such as the quality of prosecutors. However, there is no reason to assume that the quality of prosecutors of a prefecture is correlated with the number of physicians at prefecture level.

However, it is not appropriate to employ the DiD technique in this case. This is because we have only one treatment unit (Fukushima prefecture). As Conley and Taber (2011)

demonstrated, with small number of treatment units, the DiD fixed effects estimates are likely to be statistically inconsistent. Thus we cannot simply rely on the estimates of the standard DiD technique.

In addition, the imbalance between the treatment group and the control group could be a problem. In particular, when we adopt Fukushima as the only treatment jurisdiction, all other 46 prefectures go into the control jurisdiction. The control jurisdiction includes metropolitan areas, such as Tokyo and Osaka, and can have completely different trends from Fukushima, which is a typical rural area.

4.2 Synthetic Control

In contrast to the DiD method, the synthetic control method, which was proposed by Abadie and Gardeazabal (2003) and Abadie et al (2010, 2015), enables us to construct more plausible counterfactual and randomization-like inference via placebo analysis. Synthetic control method employs data-driven procedures to construct suitable control group. A synthetic control is a weighted average of the available control units, which can be a better candidate for counterfactual compared to the standard DiD procedure.

As the outcome variable, we employed the number of physicians per 100,000 population by prefecture. The most important type of physicians are those who practice obstetrics. Because most obstetricians in Japan practice gynecology at the same time, we summed up the number of 'pure' obstetricians and the number of physicians who practice obstetrics and gynecology at the same time. We also checked the number of gynecologists who do not practice obstetrics and the total number of physicians.

In order to construct synthetic controls, we employed several predictor variables. As demographics factors, we adopted total population, child population, population of females of childbearing age, number of reported pregnancies, number of hospitals, number of hospital beds, and number of several types of doctors. [19] Accounting for economic

[19]We exclude the outcome variable (number of obstetricians, number of gynecologists, number of obstetricians and gynecologists, number of total doctors) from the set of predictor variables in each specification.

factors, we included GPP, PI, and CPI for medical care expenses into the list of predictor variables. [20] All the variables are in per 100,000 population term.

With respect to the timing of the causal effect of the Ono Hospital Case, we need to consider three timing. The death of the pregnant mother happened in December 2004 and the criminal prosecution occurred in March 2006. Because the reference date of the survey of physicians, dentists and pharmacists by MHLW is October 1, we might be able to observe the first wave of the causal effects of the criminal prosecution in the 2006 data. Considering the fact that the report of the investigation board was published in May 2005 and that the media coverage of the Ono Hospital Case increased after that, it is reasonable to assume that first wave of the causal effects arrived before October 2006. [21]

However, while some physicians were quick to move, others might take time to decide. We might be able to observe such a later wave of the causal effect in the 2008 data and the 2010 data. The 2008 data and 2010 data need closer scrutiny. On August 20, 2008, the Fukushima District Court delivered the sentence of acquittal. As the reference date of the 2008 data is just one month away from the judgment, it is expected to be difficult to observe the effect of the sentence of acquittal in the 2008 data. If we believe that the sentence of acquittal had the effect of cancelling out the criminal prosecution, we will be able to observe such a swing-back in the 2010 data.

The 2012 data requires more scrutiny. Because the East Japan Great Earthquake hit the east Japan, including the Fukushima prefecture, in March a2011, the 2012 data is presumably influenced by the 2011 Great Earthquake.

[20] Unfortunately, the economic factors only cover the period from 2002 to 2008.

[21] Note that the change of the number of physicians is driven by three factors. First, some physicians may move in/out of a prefecture. Second, some elderly physicians may decide to retire. Finally, some graduates from medical schools may enter the market. While it is difficult to suspect the first factor to occur quickly, it is reasonable to suppose that the second and the third factors can occur relatively quickly.

5 Results

Because the DiD methods is not appropriate in this case, we focus on the results from the synthetic control approach [22] and show the results fromt the DiD approach in the appendix. Table 2 shows the unit-weights necessary to construct synthetic controls, that is, counterfactuals of Fukushima prefecture.

First, Figure 2 and Table 3 shows the synthetic control for the total number of physicians who specialize in obstetrics (obstetricians and obstetrician-gynecologists) in per capita (100,000) term. [23] The counterfactual synthetic control fits Fukushima prefecture well until 2004. However, in 2006 (prosecution), the number of physicians in Fukushima prefecture decreased by 0.507 compared to the counterfactual (7.72). Furthermore, it decreased by another 0.183 physicians by 2008 (two year after prosecution). In 2010 (sentence of acquittal), 0.269 more physicians disappeared from Fukushima prefecture. The overall decrease amounts to 12.6%. We found further dramatic decrease in 2012, which was supposedly caused by the 2011 Great Earthquake and the Fukushima Dai-ichi Nuclear Power Plant accident.

One negative aspect of the synthetic control method is that it is impossible to construct usual standard errors in the synthetic control method and that we cannot perform usual quantitative inference. Instead, we employ the placebo test method proposed in Abadie et al (2010). The placebo test method implements a permutation-like technique, where we apply the synthetic control method to every potential control in our sample. [24] This method tries to explore the uncertainty of the estimates and examines whether or not the estimated effect of the actual intervention is large relative to the distribution of the effects estimated for the controls not exposed to the intervention.

Figure 3 presents the placebo test for the total number of physicians who specialize in

[22] Because we cannot find a spillover effect of the Ono Hospital Case in the DiD settings as we will see in the appendix, we focus on Fukushima prefecture as the only treatment unit in the synthetic control settings.

[23] Relevant predictors (demographic variables) are also in per capita terms.

[24] In our case, we have 46 placebo prefectures because Japan has 47 prefectures.

obstetrics (obstetricians and obstetrician-gynecologists) in per capita (100,000) term. The thick line denotes the gap between the Fukushima prefecture and its synthetic control and the thin lines denote the gaps between the placebo prefectures and their synthetic controls. The figure shows that the Fukushima prefecture after the intervention (2006) belongs to the lower tail of the distribution and it is safe to say the estimated effect of the criminal prosecution is significantly large.

Figures 4 and 5 and Table 4, which show the synthetic controls for the number of physicians who specialize in both obstetrics and gynecology (obstetrician-gynecologists), illuminates the basically similar results with those of the total number of physicians who specialize in obstetrics.

Second, Figure 6 and Table 5 shows the synthetic control for the number of gynecologists. The counterfactual synthetic control fits Fukushima prefecture quite well until 2004, but Fukushima prefecture added 0.598 gynecologists in 2006 compared to the counterfactual (1.95). This trend continued until 2008, but 0.507 gynecologists disappeared from Fukushima in 2010, almost cancelling out the increase that occurred in 2006. Figure 7 is the result of the placebo test. The placebo test confirms that the estimated effect of the criminal prosecution belongs to the higher tail of the distribution and is significantly large.

Third, Figure 8 and Table 6 show the synthetic controls for the number of obstetricians. In this case, the counterfactual does not fit Fukushima prefecture. This is probably because the number of obstetricians is small and the order of the tracking error becomes considerably large. Therefore, we cannot rely on the synthetic control in this case. We can see this insignificance through the placebo test in Figure 9.

Finally, Figure 10 and Table 7 show the synthetic controls for the total number of physicians. In this case, the counterfactual fits Fukushima prefecture until 2004. In 2004, two year before the treatment intervention (the Ono Hospital Case), Fukushima prefecture experienced a small decrease of 4.02 physicians (2.26%) compared to the counterfactual (178). After that, the counterfactual and Fukushima prefecture shows almost parallel

trends until 2008. In 2010, more 5.81 physicians (2.99%) disappeared from Fukushima prefecture and Fukushima prefecture experienced a further drastic decrease in 2012, which was supposedly caused by the 2011 Great Earthquake and the Fukushima Dai-ichi Nuclear Power Plant accident. The placebo test in Figure 11 confirms that the change of the number of total physicians belong to the center of the distribution and are not significantly large until 2012.

Overall, the synthetic control estimates provide the following picture. The Ono Hospital Case decreased the number of physicians who specialize in obstetrics by 13% (a conservative estimate). Around eighty percent of them changed their business and only practiced gynecology after the Ono Hospital Case. This was because gynecologists do not practice delivery and therefore are involved in much lower risk activities than obstetricians. However, the effect of the change of business disappeared by 2010 (four years after prosecution). Obstetricians, including those who had changed their business to gynecology, decided to get out of Fukushima prefecture by 2010. The sentence of acquittal did not change the situation.

6 Concluding Remarks

This paper tries to identify the causal effect of criminal prosecution by utilizing an exogenous schock over the likelihood of criminal prosecution. The analysis shows that a criminal prosecution reduced the number of physicians in Fukushima prefecture who engage in obstetrics by 18 during the following six years. Nine of them changed their business from obstetrics to gynecology, which does not involve delivery and is much less risky. Others disappeared from Fukushima prefecture and moved to other prefectures. However, those who changed their business to gynecology finally disappeared from Fukushima prefecture six years after the criminal prosecution. The sentence of acquittal did not change the situation and the number of physicians in Fukushima prefecture who engage in obstetrics did not return to its former number. This amounted to a 13% decrease of physicians in Fukushima prefecture, which must have led to a serious

deterioration in medical care.

In contrast, the Ono Hospital Case did not have any impact on the total supply of physicians. This result confirms the observation of Klick and Stratmann (2007) that many doctors are likely to be indifferent regarding medical malpractice, because their likelihood of being sued is low. They show that the effect of medical malpractice tort reform is concentrated among only those specialties that face the highest litigation exposure. Here we show that the causal effect of criminal prosecution is concentrated among only obstetricians and gynecologists, not among physicians overall.

Considering the fact that the training cost of a physician amounts to tens of millions of yen (hundreds of thousands of dollars) per physician, a single criminal prosecution of physician generated damages of over a billion yen (ten million dollars) to Fukushima prefecture. In addition, the deterioration in the medical care environment in Fukushima prefecture could have caused deteriorated health outcomes, such as higher infant mortality and lower number of pregnancies. Taking this factor into account, the social cost of criminal prosecution is huge. Whether the benefit of criminal prosecution of a physician, namely its deterrent effect, outweighs its social cost is disputable.

Even though the relatively weak estimates in the current literature cause some to doubt whether influences of medical malpractice tort are meaningful determinants of physician behavior, extreme sanction like criminal imprisonment could have serious effect on physician behavior. We need to be cautious about strengthening the present medical malpractice tort sanctions.

There are several caveats to these estimates. First, the estimates are the lower bounds, as our identification strategy does not allow us to separately identify the spillover effect on a nationwide scale. We identify only the difference of the causal effect among prefectures. Taking the spillover effect into account, the true causal effect of criminal prosecution may be even larger.

Second, among the physicians in Fukushima prefecture, the population of those physicians who moved out of Fukushima prefecture may be skewed. Although we do not have

age structure data for physicians, it is expected that elderly physicians who are practicing privately tend to stay, while younger and active physicians who are working in larger hospitals tend to leave, as the latter have fewer sunk cost and are able to find new jobs in other prefectures more easily. This bias may lead to exacerbated deterioration of the medical care environment in Fukushima prefecture.

Third, it is possible that the Ono Hospital Case did not change the likelihood of criminal prosecution in Fukushima prefecture, but that it did change the risk perception of physicians. Because prosecutors in Japan are relocated every few years in order to avoid corruption, it is not rational to assume that the Ono Hospital Case changed the likelihood of criminal prosecution in Fukushima prefecture permanently. However, physicians may be subject to the representativeness bias (Kahneman and Tversky 1972) and react irrationally to a single criminal prosecution.

The analysis of the paper also sheds light on another aspect of criminal prosecution. Starting from Becker (1968), the crime and sanction literature has focused on the deterrent effect of criminal sanctions and the enforcement environment. The paper shows that criminal prosecution itself has a significant deterrent effect and a sentence of acquittal does not cancel this. The probability of criminal sanction does not matter, but criminal prosecution does. This is probably because criminal prosecution of a physician causes many social sanctions, such as loss of a job, a fall in reputation, and social stigma. [25] The results illuminate the importance of taking social sanctions into consideration when we analyze the deterrent effect of criminal law and sanctions.

[25]Medical license in Japan is suspended by conviction, but not by criminal prosecution.

Appendix

Difference-in-Differences

Under the DiD setting, we estimate the following model:

$$Y_{ist} = \alpha_i + \gamma J_s + \lambda d_t + \delta D_{st} + X_{ist}\beta + \epsilon_{ist}$$

where Y is the number of physicians, α denotes prefecture fixed effect, J denotes whether each unit is in the treatment or the control jurisdiction, d denotes whether the year is after the Ono Hospital Case or not, D denotes the treatment status ($= J_s \cdot d_t$), and X is the vector of covariates. In this setting, δ is the coefficient of our interest.

There are several caveats with respect to this DiD setting. First, it might be better to be cautious about the geographic scope of the spillover effect of the Ono Hospital Case. As discussed above, the most plausible assumption is that this has the most serious effect only in Fukushima prefecture. At the same time, the prosecutors in Fukushima prefecture are supervised by the prosecutors who belong to the appeal court — Sendai High Court, in the case of Fukushima District Court. Thus, physicians working in the jurisdiction of the Sendai High Court might fear the increased possibility of criminal prosecution. Considering this scenario, we employed two types of treatment/control distinctions (J): the basic specification assumes that Fukushima prefecture is the only treatment jurisdiction, while the robust specification assumes that prefectures within the jurisdiction of Sendai High Court — Aomori, Iwate, Akita, Miyagi, Yamagata, and Fukushima prefectures — are the treatment jurisdiction.

Second, there are multiple timing with respect to the timing of the causal effect of the Ono Hospital Case. The death of the pregnant mother happened in December 2004 and the criminal prosecution occurred in March 2006. Finally on August 20, 2008, the Fukushima District Court delivered the sentence of acquittal. Note that the reference date of the survey of physicians, dentists and pharmacists is October 1.

Cosidering these timeline, we adopted three time indicators for treatment (d). The first indicator differentiates between before 2004 and after 2006, the second differentiates

between 2006 and 2008, and the third differentiates between 2008 and 2010. By checking under which specification we can observe the effect of the Ono Hospital Case, we can identify which effect was more serious.

Finally, with respect to the covariates, we employ two sets. The first set consists of demographics factors: total population, child population, and population of females of childbearing age. The second set consists of economic factors: GPP, PI, and CPI for medical care expenses. Unfortunately, the second set of covariates only covers the period from 2002 to 2008 and adopting this set reduces the sample size dramatically. Therefore, we account for economic factors as supplementary specifications.

Results

The results from the DiD settings basically reaffirmed those from the synthetic control settings.

First, we see the specifications where only Fukushima prefecture is the treatment jurisdiction (Tables 8 - 12).

Table 8 shows the results where the dependent variable is the total number of physicians who specialize in obstetrics, that is, obstetricians and physicians who specialize in both obstetrics and gynecology (obstetricians and obstetrician-gynecologists). We use three types of specifications, where number of physicians and demographic covariates factors are in level form, logarithmic form, or in per capita (per 100,000 population).

Here we find a consistent negative causal effect of the Ono Hospital Case. The DiD estimators are strongly significant and their signs are negative. The magnitude of estimates from the per capita specifications are minus 0.175 physicians in 2006, minus 0.374 physicians in 2008, and minus 0.399 physicians in 2010 without controlling economic factors, and after controlling economic factors, minus 0.186 physicians in 2006 and minus 0.316 physicians in 2008. [26] Because the average per capita physicians who engage in obstetrics in Fukushima from 1996 to 2012 is 7.55, the estimates are substantive and the sum of

[26]Note that the data point is every two years.

them amounts to 12.6% decrease (without controlling economic factors). The level specifications and the logarithmic specifications show basically the same feature as the per capita specifications.

The magnitude of estimates are considerable and the Ono Hospital Case had a serious impact on physician supply in Fukushima prefecture. The DiD estimates are significant at every timing and we can conclude that the acquittal sentence did not cancel out the initial criminal prosecution.

In contrast, the number of physicians in Fukushima prefecture who specialize only in gynecology increased after the the Ono Hospital Case. Table 9 shows the results where the dependent variable is the number of physicians who specialize in gynecology. The DiD estimates in the per capita specifications show significant positive effect of the Ono Hospital Case. The case increased gynecologists in Fukushima prefecture by 0.444 in 2006 and 0.288 in 2008 without controlling for economic factors. Even after controlling for economic factors, gynecologists in Fukushima prefecture increased by 0.362 in 2006 and 0.258 in 2008. Looking at the level specifications and the logarithmic specifications essentially reveals similar results.

Considering that the average per capita gynecologists in Fukushima from 1996 to 2012 is 7.28, the magnitute of the estimates is substantive. The overall increase in 2006 and 2008 amounts to 10% increase. However, the increase of gynecologists that happened in 2006 and 2008 almost disappeared in 2010, when the sentence of acquittal was delivered.

Turning to the number of physicians who specialize in both obstetrics and gynecology (obstetrician-gynecologists), Table 10 shows essentially similar results to those of the total number of physicians who specialize in obstetrics (Table 8). In the number of physicians who specialize only in obstetrics, the estimates show a drastic increase and decrease (Table 11). This is because the number of obstetricians in Fukushima prefecture is small (its mean from 1996 to 2012 is 5.7, maximum is 8, and minimum is 2). Therefore, it is not reasonable to consider the number of obstetricians alone. Rather, we need to observe the change in the total number of physicians who specialize in obstetrics (Table 8).

Next, we want to check whether the Ono the Hospital Case affected not only obstetricians but also all types of physicians. Table 12 shows the results. While the DiD estimates are strongly significant and have negative signs in specifications where we did not control for economic factors, part of the negative effects vanish once we do control them. This implies that the apparent causal effect of the Ono Hospital Case on physicians in Fukushima prefecture overall were mainly driven by economic factors. In addition, from the result of synthetic control analysis (figure 10 and table 7), we find that the total number of physicians in Fukushima prefecture had already decreased before the treatment (2004). The significant negative effect observed in 2006 is presumably driven by this preceding decrease of physicians in Fukushima prefecture. [27]

Finally, we check whether the Ono Hospital Case had spillover effects in Sendai High Court jurisdiction. Tables 13 through 17 show the results where the jurisdiction of Sendai High Court — Aomori, Iwate, Akita, Miyagi, Yamagata, and Fukushima prefectures — are the treatment jurisdiction. The DiD estimates indicate no statistically significant effect (at least after controlling economic factors) and we can conclude that the effects of the Ono Hospital Case were concentrated in Fukushima prefecture and that there was no spillover effect.

[27]When we include a placebo year treatment dummy of 2004, the significant negative effect observed in 2006 dissappears.

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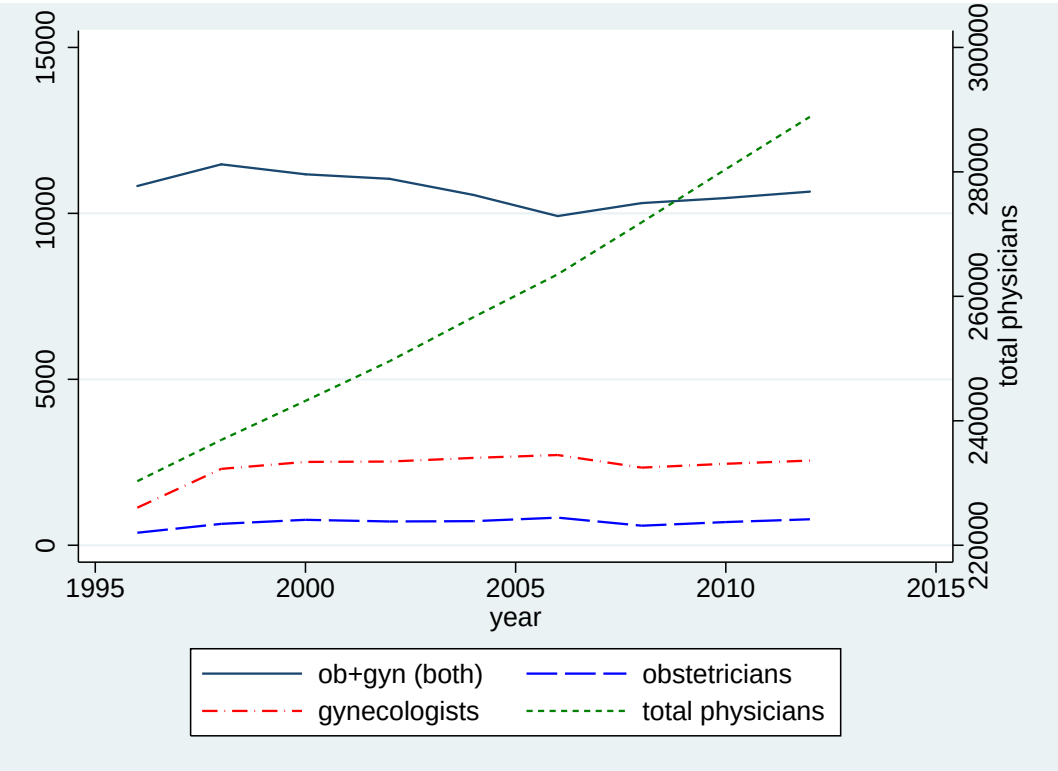

Figure 1: Number of physicians

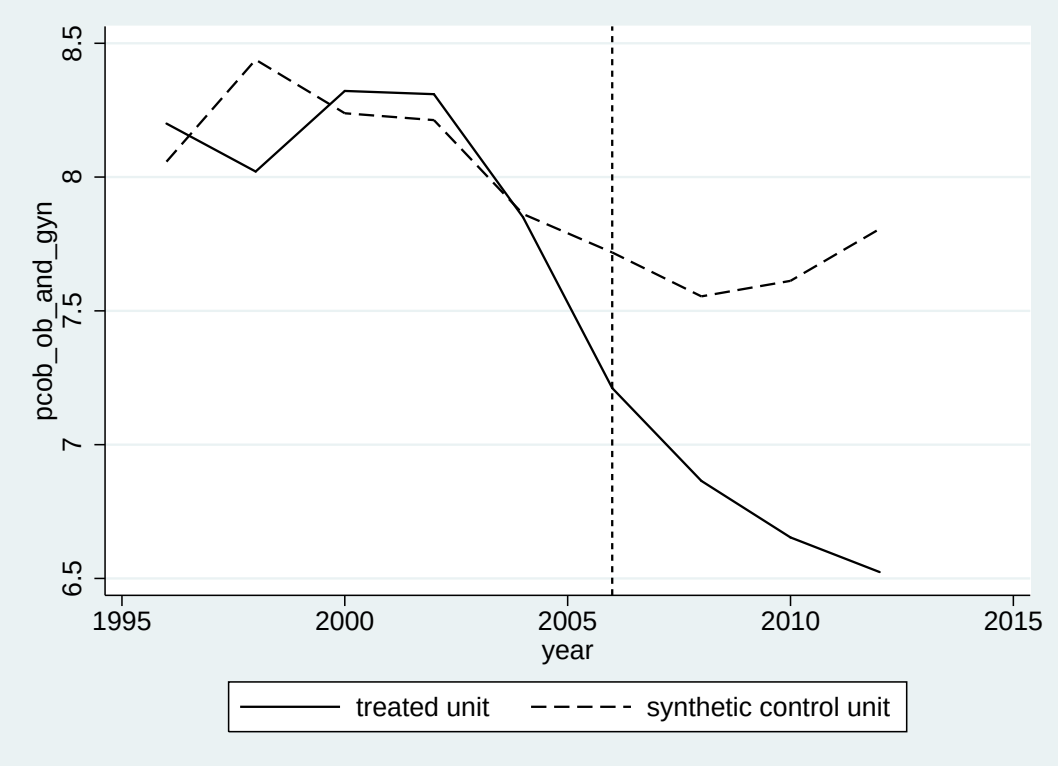

Figure 2: Synthetic control: all obstetricians (per capita)

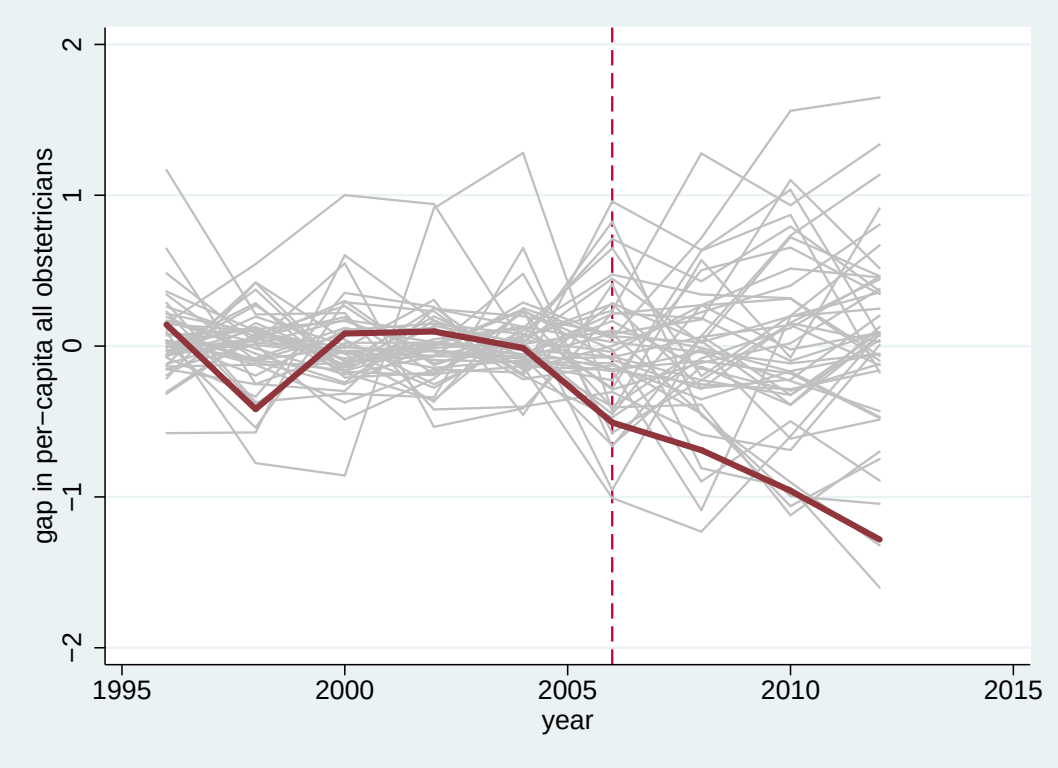

Figure 3: Placebo test: all obstetricians (per capita)

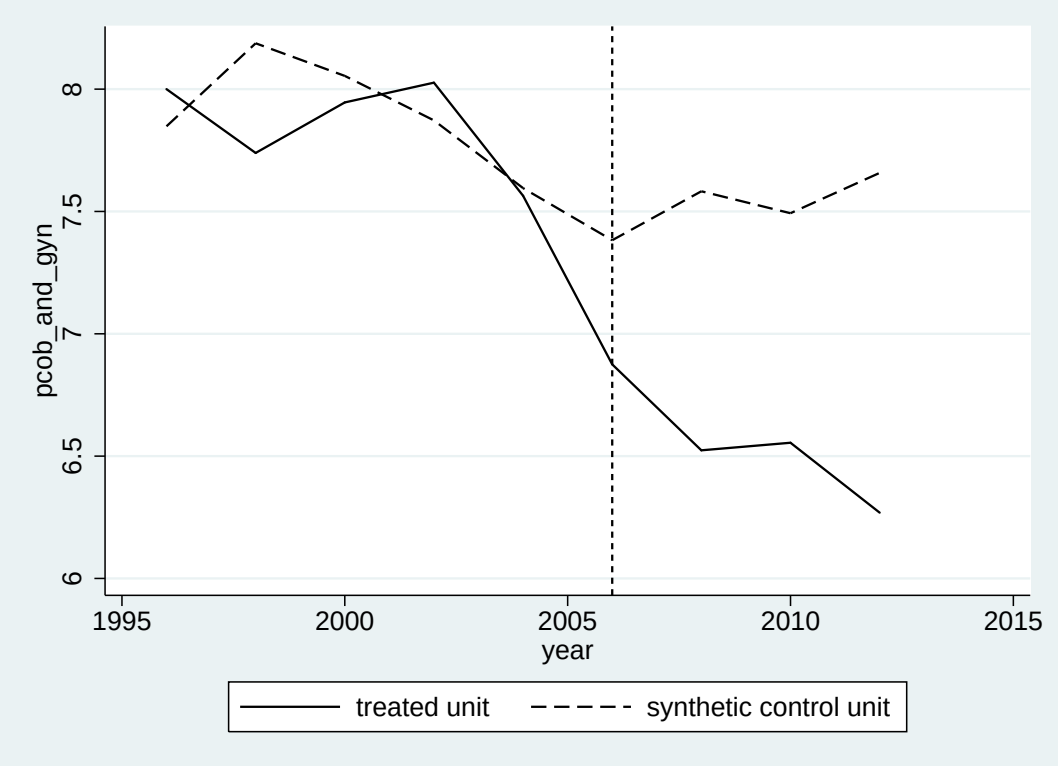

Figure 4: Synthetic control: obstetrician-gynecologists (per capita)

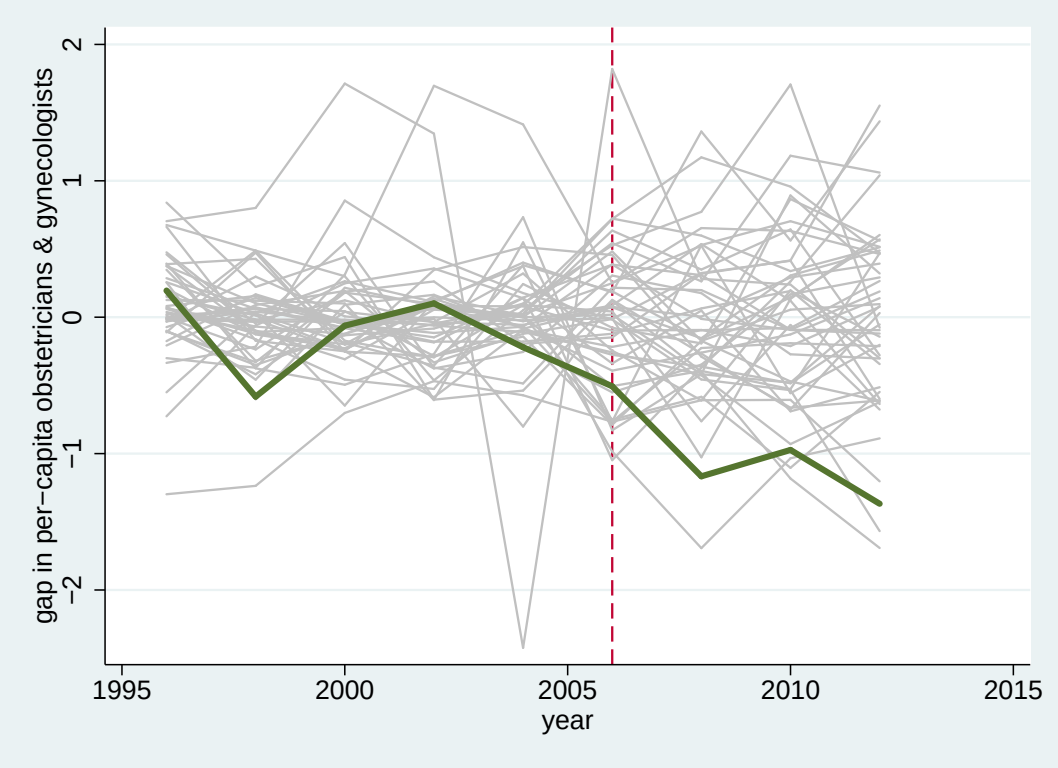

Figure 5: Placebo test: obstetrician-gynecologists (per capita)

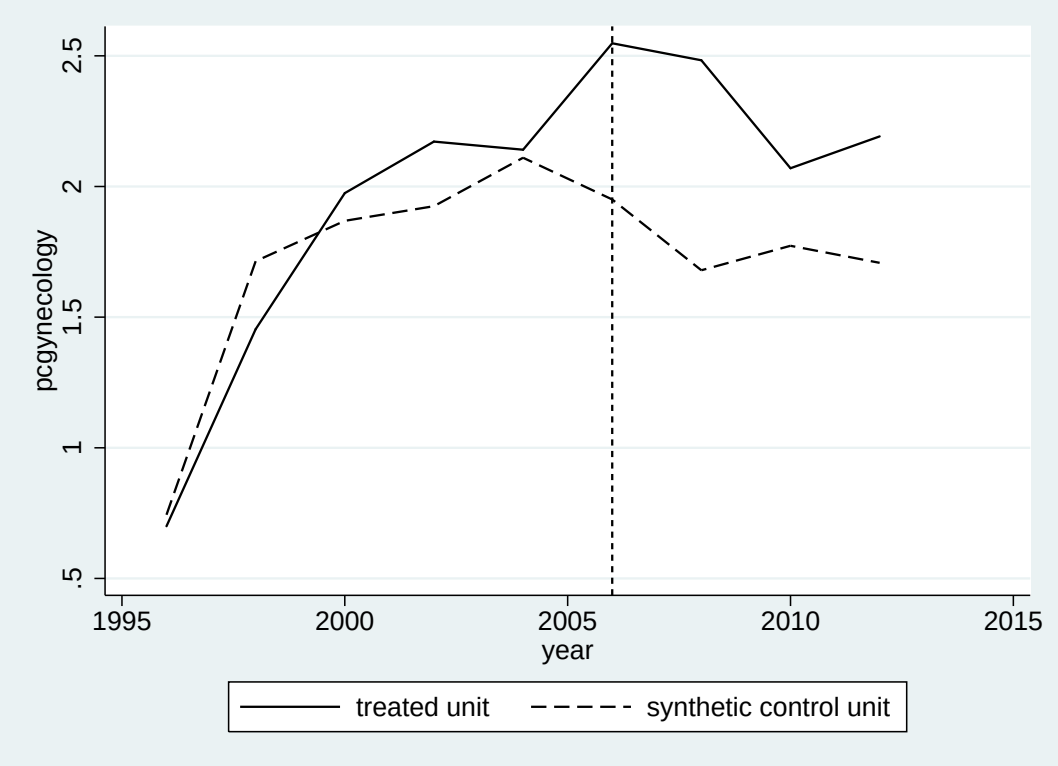

Figure 6: Synthetic control: gynecologists (per capita)

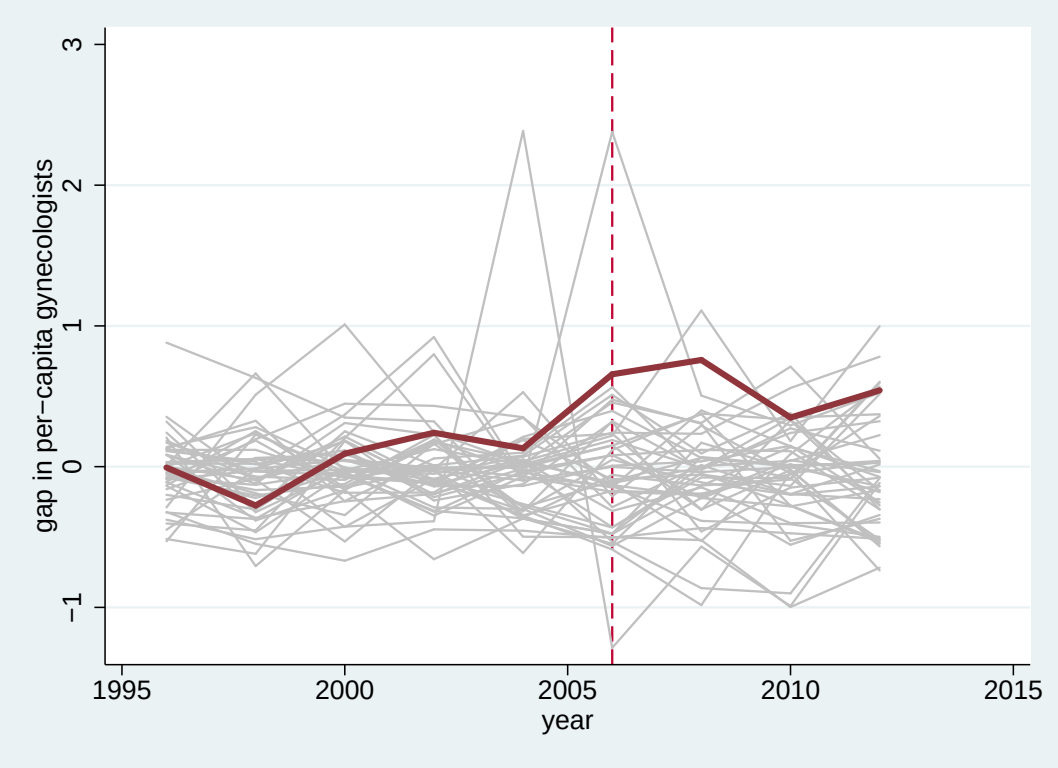

Figure 7: Placebo test: gynecologists (per capita)

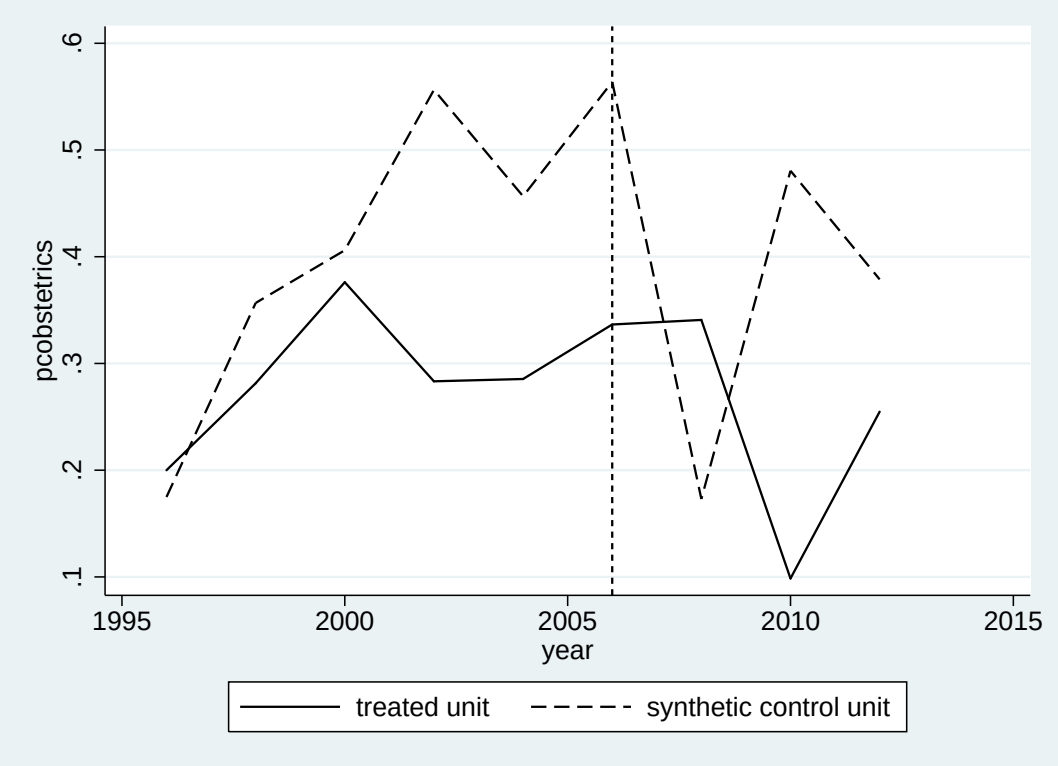

Figure 8: Synthetic control: obstetricians (per capita)

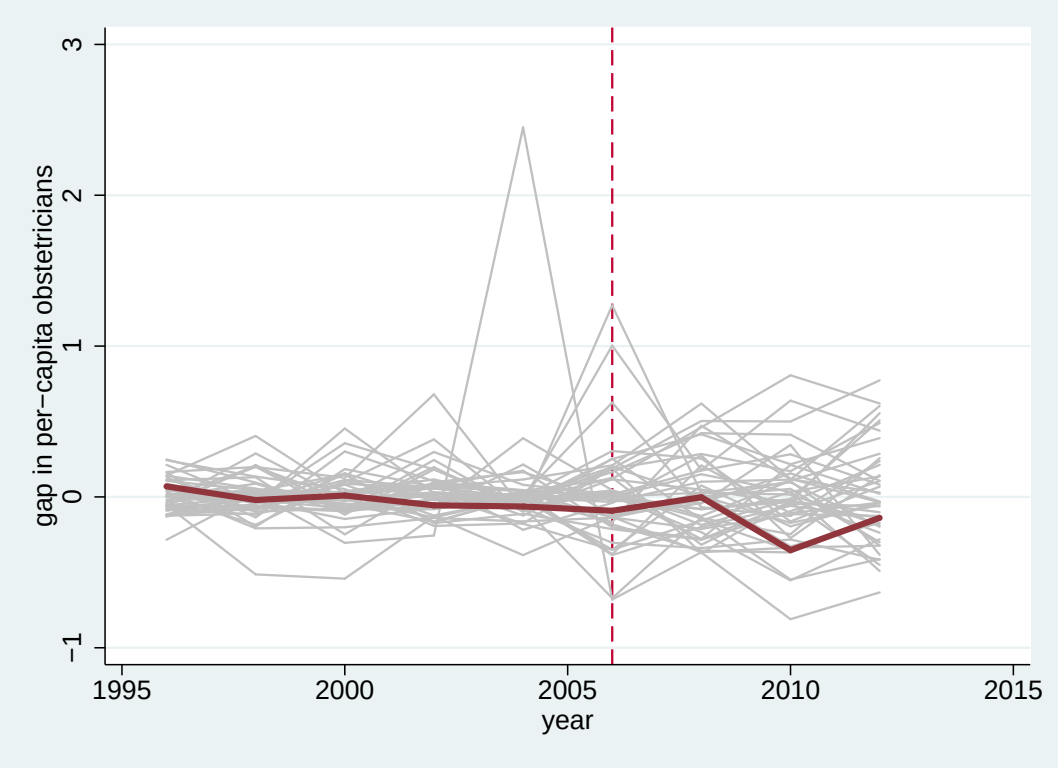

Figure 9: Placebo test: obstetricians (per capita)

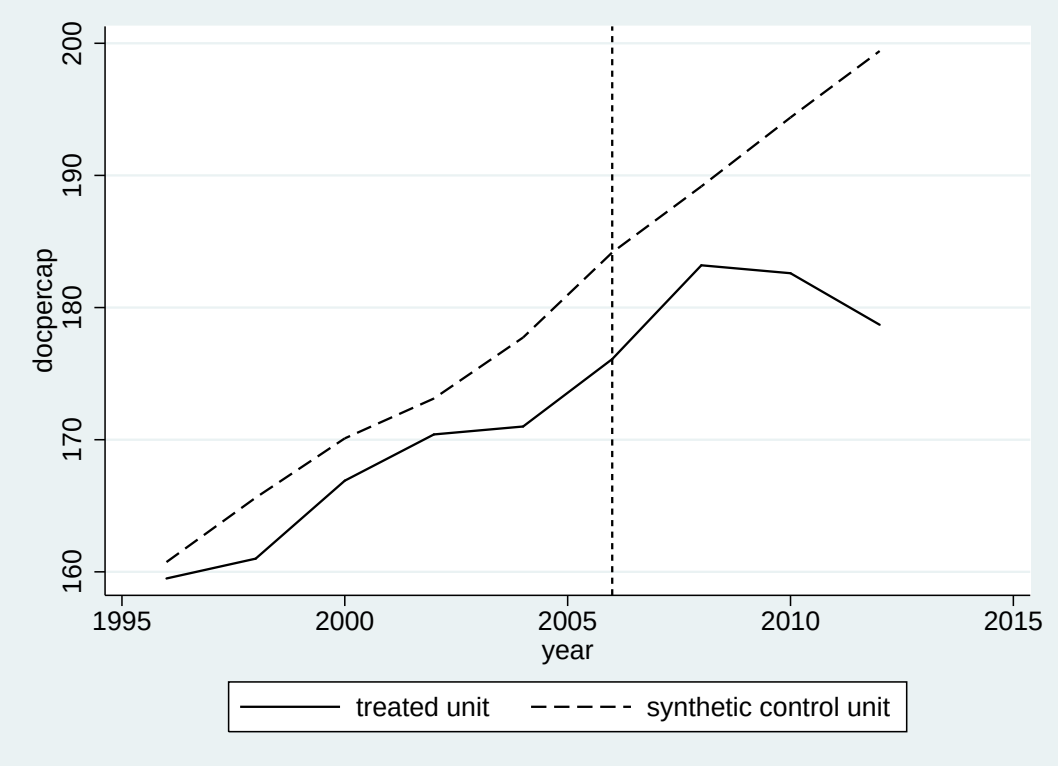

Figure 10: Synthetic control: all types of physicians (per capita)

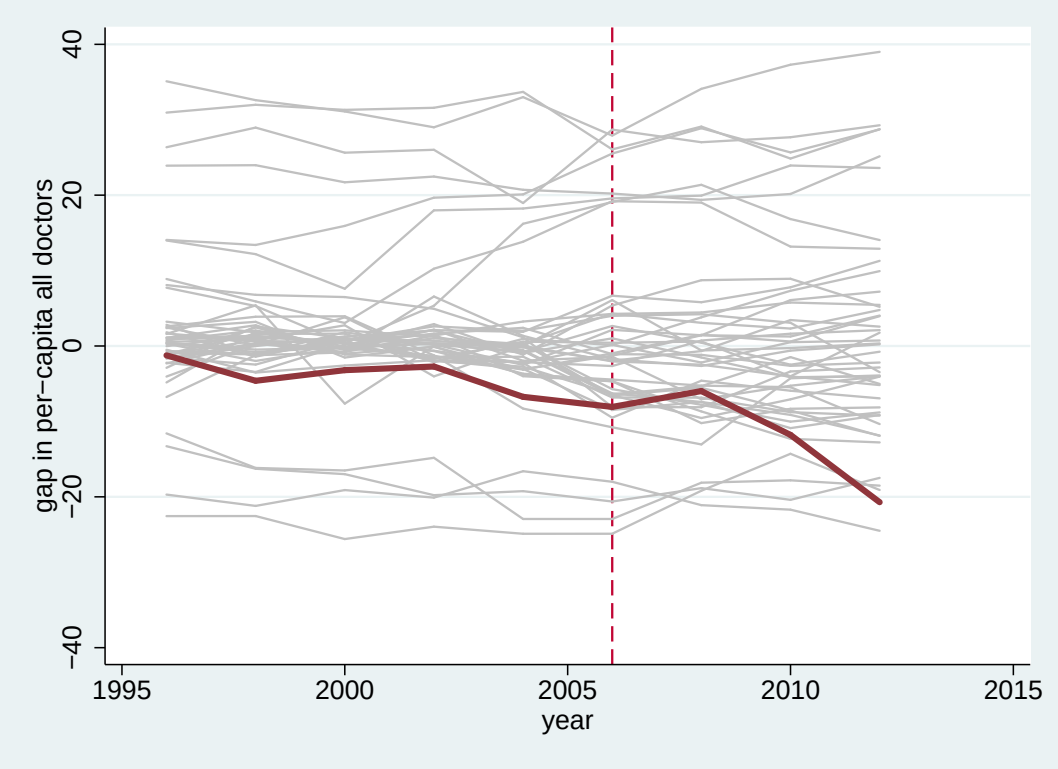

Figure 11: Placebo test: all types of physicians (per capita)

Table 1: Summary statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
GPP	235	10986767	15096879	1786321	99873101
PI	235	2765	442	1995	5235
CPI for medical care expenses	329	97.7	3.87	84.6	103.3
Total Population	423	2709426	2560593	582000	13230000
Child population	423	380652	338800	77000	1517000
Female population with childbearing age	423	606964	613508	109000	3171000
Reported pregnancy	423	24839	24405	4902	122879
Hospital	423	193	145	42	704
(per capita)	423	8.36	3.26	3.79	18.5
Hospital bed	423	34634	27738	8629	13848
(per capita)	423	1434	357	813	2603
Physician	423	5488	5775	1411	39116
(per capita)	423	207	37.7	109.8	296.7
Obstetrician-gynecologist	423	228	239	46	1493
Obstetrician	423	14.6	17.9	0	131
All obstetricians	423	243	255	51	1598
(per capita)	423	9.07	1.43	5.8	13.5
Gynecologist	423	50.1	68.2	2.65	458
(per capita)	423	1.73	0.641	0.3	5.25

Per capita means per 100,000 population.

Table 2: Unit weights of synthetic controls

Prefecture	Ob-Gyn	Obstetrics	Gynecology	Ob & Ob-Gyn	All Physician
Hokkaido	0	0	0	0	0
Aomori	0	0.011	0	0	0.131
Iwate	0	0	0	0.099	0
Miyagi	0	0	0	0	0
Akita	0.157	0	0	0	0
Yamagata	0.151	0	0	0.25	0
Fukushima	—	—	—	—	—
Ibaraki	0.48	0.561	0.401	0.416	0
Tochigi	0	0	0	0	0
Gunma	0	0	0	0	0
Saitama	0	0	0	0	0
Chiba	0	0	0	0	0
Tokyo	0	0	0	0	0
Kanagawa	0	0	0	0	0
Niigata	0	0	0.212	0.001	0.553
Toyama	0	0	0	0	0
Ishikawa	0	0	0	0	0
Fukui	0	0	0	0	0
Yamanashi	0	0	0	0	0
Nagano	0	0	0	0	0
Gifu	0	0	0	0	0
Shizuoka	0	0.	0	0	0
Aichi	0	0.	0	0	0
Mie	0	0	0	0	0
Shiga	0	0.049	0	0.055	0
Kyoto	0	0	0	0	0
Osaka	0	0	0	0.006	0
Hyogo	0	0	0	0	0
Nara	0	0	0	0	0
Wakayama	0	0	0	0	0
Tottori	0	0	0	0	0
Shimane	0	0	0	0	0
Okayama	0	0	0	0	0
Hiroshima	0	0	0	0	0
Yamaguchi	0	0	0.013	0	0
Tokushima	0	0	0	0	0
Kagawa	0	0	0	0	0
Ehime	0.033	0	0	0	0
Kochi	0.07	0.185	0.152	0.101	0
Fukuoka	0	0	0	0	0
Saga	0	0	0	0	0
Nagasaki	0	0	0	0	0
Kumamoto	0.1	0	0	0.072	0
Oita	0	0	0	0	0
Miyazaki	0	0	0	0	0
Kagoshima	0	0	0	0	0.116
Okinawa	0.001	0.194	0.222	0	0.2

Table 3: Synthetic control: All obstetricians (per capita)

Year	Fukushima	Synthetic Control	Difference
1996	8.20	8.06	0.142
1998	8.02	8.44	-0.418
2000	8.32	8.24	0.0834
2002	8.31	8.21	0.0968
2004	7.85	7.86	-0.0123
2006	7.21	7.72	-0.507
2008	6.86	7.55	-0.690
2010	6.651	7.61	-0.959
2012	6.52	7.81	-1.282

Table 4: Synthetic control: Obstetrician-Gynecologists (per capita)

Year	Fukushima	Synthetic Control	Difference
1996	8	7.85	0.152
1998	7.74	8.19	-0.448
2000	7.95	8.05	-0.108
2002	8.03	7.87	0.154
2004	7.56	7.60	-0.0313
2006	6.88	7.38	-0.508
2008	6.53	7.58	-1.059
2010	6.55	7.49	-0.938
2012	6.27	7.66	-1.389

Table 5: Synthetic control: Gynecologists (per capita)

Year	Fukushima	Synthetic Control	Difference
1996	0.700	0.744	-0.044
1998	1.45	1.71	-0.260
2000	1.97	1.87	0.106
2002	2.17	1.92	0.247
2004	2.14	2.11	0.031
2006	2.55	1.95	0.598
2008	2.48	1.68	0.804
2010	2.07	1.77	0.297
2012	2.19	1.71	0.484

Table 6: Synthetic control: Obstetricians (per capita)

Year	Fukushima	Synthetic Control	Difference
1996	0.2	0.175	0.025
1998	0.281	0.357	-0.075
2000	0.376	0.406	-0.030
2002	0.283	0.556	-0.273
2004	0.285	0.457	-0.171
2006	0.337	0.564	-0.227
2008	0.341	0.173	0.168
2010	0.099	0.481	-0.382
2012	0.255	0.379	-0.124

Table 7: Synthetic control: All types of physicians (per capita)

Year	Fukushima	Synthetic Control	Difference
1996	159.5	160.7	-1.24
1998	161	165.6	-4.61
2000	166.9	170.1	-3.20
2002	170.4	173.1	-2.72
2004	171	177.7	-6.77
2006	176.1	184.2	-8.07
2008	183.2	189.2	-5.97
2010	182.6	194.4	-11.8
2012	178.7	199.4	-20.7

Table 8: Obstetricians, Obstetricians + Gynecologists

Dependent variable	Obstetricians, Obstetrician-Gynecologists					
	Level		Log		PerCap	
Prosecution$\cdot J$	-4.97*	-4.30**	-0.0325***	-0.0387***	-0.175**	-0.186***
	(2.88)	(1.84)	(0.0080)	(0.0087)	(0.0762)	(0.0826)
(Prosecute+2Y)$\cdot J$	-11.65***	-8.69***	-0.0539***	-0.0493***	-0.374***	-0.316***
	(2.19)	(1.74)	(0.0108)	(0.0141)	(0.0858)	(0.122)
Acquittal$\cdot J$	-10.92***		-0.0528***		-0.399***	
	(2.38)		(0.0078)		(0.0650)	
Demographic factors	Yes	Yes	Yes	Yes	Yes	Yes
Economic factors	No	Yes	No	Yes	No	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	376	188	376	188	376	188
R^2	0.424	0.589	0.632	0.633	0.403	0.572

*, **, and *** denote 10%, 5%, and 1% significance level respectively.
Clustered standard errors are in parentheses.

Table 9: Gynecologists

Dependent variable	Gynecologists					
	Level		Log		PerCap	
Prosecution$\cdot J$	10.33***	4.39***	0.195***	0.156***	0.444***	0.362***
	(1.40)	(1.30)	(0.0439)	(0.0274)	(0.0791)	(0.0617)
(Prosecute+2Y)$\cdot J$	6.46***	4.47***	0.159***	0.176***	0.288***	0.258***
	(1.79)	(1.17)	(0.0397)	(0.0379)	(0.0677)	(0.0612)
Acquittal$\cdot J$	-11.15***		-0.248***		-0.506***	
	(0.948)		(0.0283)		(0.0445)	
Demographic factors	Yes	Yes	Yes	Yes	Yes	Yes
Economic factors	No	Yes	No	Yes	No	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	376	188	376	188	376	188
R^2	0.612	0.341	0.711	0.238	0.562	0.150

*, **, and *** denote 10%, 5%, and 1% significance level respectively.
Clustered standard errors are in parentheses.

Table 10: Obstetricians + Gynecologists

Dependent variable	Obstetrician-Gynecologists					
	Level		Log		PerCap	
Prosecution $\cdot J$	-0.458	-1.39	-0.0191**	-0.0421***	-0.0642	-0.216**
	(3.16)	(2.25)	(0.0090)	(0.0103)	(0.0834)	(0.0844)
(Prosecute+2Y)$\cdot J$	-16.61***	-12.70***	-0.0885***	-0.0818***	-0.644***	-0.583***
	(2.50)	(1.73)	(0.0102)	(0.0161)	(0.0782)	(0.131)
Acquittal$\cdot J$	-3.57		-0.0049		-0.0555	
	(2.23)		(0.0091)		(0.0712)	
Demographic factors	Yes	Yes	Yes	Yes	Yes	Yes
Economic factors	No	Yes	No	Yes	No	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	376	188	376	188	376	188
R^2	0.434	0.615	0.560	0.477	0.460	0.407

*, **, and *** denote 10%, 5%, and 1% significance level respectively.
Clustered standard errors are in parentheses.

Table 11: Obstetricians

Dependent variable	Obstetricians					
	Level		Log		PerCap	
Prosecution$\cdot J$	-4.51**	-2.91**	-0.121*	0.145	-0.111***	0.0301
	(1.83)	(1.26)	(0.0701)	(0.101)	(0.0388)	(0.0522)
(Prosecute+2Y)$\cdot J$	4.97***	4.00***	0.572***	0.649***	0.271***	0.267***
	(1.01)	(1.00)	(0.108)	(0.155)	(0.0536)	(0.0738)
Acquittal$\cdot J$	-7.35***		-1.56***		-0.343***	
	(0.971)		(0.0946)		(0.0340)	
Demographic factors	Yes	Yes	Yes	Yes	Yes	Yes
Economic factors	No	Yes	No	Yes	No	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	376	188	365	185	376	188
R^2	0.332	0.350	0.271	0.249	0.177	0.124

*, **, and *** denote 10%, 5%, and 1% significance level respectively.
Clustered standard errors are in parentheses.

Table 12: All types of physicians

Dependent variable	All types of physicians					
	Level		Log		PerCap	
Prosecution$\cdot J$	-112.52***	-11.39	-0.0199***	-0.0106***	-6.43***	-3.09***
	(35.37)	(36.01)	(-0.0043)	(0.0038)	(1.31)	(1.06)
(Prosecute+2Y)$\cdot J$	4.02	23.56	0.0067**	0.0079*	0.670	0.159
	(23.46)	(21.06)	(0.0030)	(0.0042)	(0.570)	(0.854)
Acquittal$\cdot J$	-149.70***		-0.0351***		-7.21***	
	(18.67)		(0.0027)		(0.624)	
Demographic factors	Yes	Yes	Yes	Yes	Yes	Yes
Economic factors	No	Yes	No	Yes	No	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	376	188	376	188	376	188
R^2	0.934	0.941	0.923	0.841	0.923	0.852

*, **, and *** denote 10%, 5%, and 1% significance level respectively.
Clustered standard errors are in parentheses.

Table 13: Obstetricians, Obstetrician-Gynecologists: Sendai High Court effect

Dependent variable	Obstetricians, Obstetricians + Gynecologists					
	Level		Log		PerCap	
Prosecution$\cdot J$	1.03	-1.79	-0.0205	-0.0128	-0.119	-0.0398
	(3.86)	(4.10)	(0.0173)	(0.0241)	(0.129)	(0.211)
(Prosecute+2Y)$\cdot J$	-2.31	0.765	0.0211	0.0295	0.148	0.260
	(4.20)	(3.85)	(0.0275)	(0.0281)	(0.224)	(0.231)
Acquittal$\cdot J$	-4.76*		-0.0055		-0.0484	
	(2.74)		(0.0167)		(0.139)	
Demographic factors	Yes	Yes	Yes	Yes	Yes	Yes
Economic factors	No	Yes	No	Yes	No	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	376	188	376	188	376	188
R^2	0.418	0.586	0.623	0.629	0.516	0.573

*, **, and *** denote 10%, 5%, and 1% significance level respectively.
Clustered standard errors are in parentheses.

Table 14: Gynecologists: Sendai High Court effect

Dependent variable	Gynecologists					
	Level		Log		PerCap	
Prosecution$\cdot J$	1.09	-0.672	-0.0064	0.0128	-0.0269	-0.0068
	(2.45)	(1.65)	(0.108)	(0.0597)	(0.166)	(0.118)
(Prosecute+2Y)$\cdot J$	4.81*	0.408	-0.0875	-0.0359	-0.0399	0.0091
	(2.78)	(1.95)	(0.118)	(0.115)	(0.149)	(0.168)
Acquittal$\cdot J$	-0.321		0.104		0.129	
	(2.75)		(0.0923)		(0.151)	
Demographic factors	Yes	Yes	Yes	Yes	Yes	Yes
Economic factors	No	Yes	No	Yes	No	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	376	188	376	188	376	188
R^2	0.612	0.335	0.709	0.223	0.557	0.137

*, **, and *** denote 10%, 5%, and 1% significance level respectively.
Clustered standard errors are in parentheses.

Table 15: Obstetrician-Gynecologists: Sendai High Court effect

Dependent variable	Obstetricians + Gynecologists					
	Level		Log		PerCap	
Prosecution$\cdot J$	2.55	-0.389	-0.0244	-0.0211	-0.0119	-0.0481
	(4.50)	(4.39)	(0.0240)	(0.0268)	(0.167)	(0.219)
(Prosecute+2Y)$\cdot J$	-6.40	-1.57	0.0086	0.0037	-0.0089	0.0260
	(4.27)	(3.50)	(0.0306)	(0.0312)	(0.228)	(0.239)
Acquittal$\cdot J$	-4.29		-0.0039		-0.0469	
	(2.66)		(0.0162)		(0.120)	
Demographic factors	Yes	Yes	Yes	Yes	Yes	Yes
Economic factors	No	Yes	No	Yes	No	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	376	188	376	188	376	188
R^2	0.433	0.611	0.554	0.468	0.456	0.399

*, **, and *** denote 10%, 5%, and 1% significance level respectively.
Clustered standard errors are in parentheses.

Table 16: Obstetricians: Sendai High Court effect

Dependent variable	Obstetricians					
	Level		Log		PerCap	
Prosecution$\cdot J$	-1.52	-1.40	0.0753	0.155	0.0008	-0.0082
	(1.51)	(1.13)	(0.110)	(0.111)	(0.0668)	(0.0633)
(Prosecute+2Y)$\cdot J$	4.09***	2.34	0.379**	0.516***	0.157**	0.234**
	(1.36)	(1.62)	(0.182)	(0.178)	(0.0770)	(0.0905)
Acquittal$\cdot J$	-0.470		-0.297		-0.0015	
	(2.05)		(0.356)		(0.104)	
Demographic factors	Yes	Yes	Yes	Yes	Yes	Yes
Economic factors	No	Yes	No	Yes	No	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	376	188	365	185	376	188
R^2	0.333	0.351	0.263	0.268	0.181	0.133

*, **, and *** denote 10%, 5%, and 1% significance level respectively.
Clustered standard errors are in parentheses.

Table 17: All types of physicians: Sendai High Court effect

Dependent variable	All types of physicians					
	Level		Log		PerCap	
Prosecution$\cdot J$	-35.42	36.12	-0.0062	0.0040	-4.02**	-0.842
	(36.80)	(29.19)	(0.0070)	(0.0052)	(1.79)	(1.31)
(Prosecute+2Y)$\cdot J$	-31.46	33.03*	0.0034	0.0064	-0.664	-0.828
	(33.52)	(18.02)	(0.0042)	(0.0044)	(1.14)	(1.30)
Acquittal$\cdot J$	-23.80		0.0020		0.0315	
	(34.52)		(0.0096)		(1.90)	
Demographic factors	Yes	Yes	Yes	Yes	Yes	Yes
Economic factors	No	Yes	No	Yes	No	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	376	188	376	188	376	188
R^2	0.934	0.942	0.922	0.842	0.923	0.851

*, **, and *** denote 10%, 5%, and 1% significance level respectively.
Clustered standard errors are in parentheses.