Predictive Analytics and Medical Errors

Advances in Predictive Analytics

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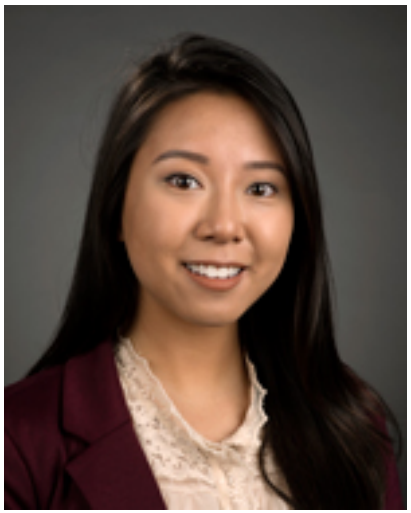
December 2017

Outline

Research Team



Insurance Analytics Resources

In this first part of the talk, I introduce two resources

- for actuaries wishing to learn more about analytics
  - A two volume series, published by *Cambridge University Press*.
- for statisticians/machine learners/financial engineers wishing to learn more about insurance company operations
  - A review paper entitled *Analytics of Insurance Markets*, in the *Annual Review of Financial Economics* 2016.

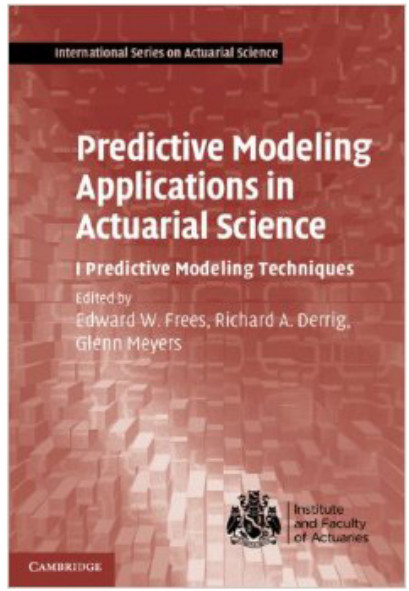
WISCONSIN SCHOOL OF BUSINESS
UNIVERSITY OF WISCONSIN–MADISON
TOGETHER FORWARD

Predictive Modeling Applications in Actuarial Science

Welcome!

This is the new website for *Predictive Modeling Applications in Actuarial Science*, a two volume series that we are creating.

This website currently focuses on Volume 1. We provide content preview, data(.txt or .csv format) and R code(.R format) for each chapter here. Contact authors for further information about data and code.



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Predictive Modeling Series

- This two volume set provides the foundations of statistical modeling for actuaries interested in learning about predictive analytics
  - I am a co-Editor, along with Glenn Meyers and Richard Derrig
  - Authors from 7 different countries
- Book URL `http://research.bus.wisc.edu/PredModelActuaries`
- Volume 2, on case studies, appeared last year
- Translated by the Japanese Institute of Actuaries
- Co-sponsored by the Canadian Institute of Actuaries

What is Analytics?

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- Insurance is a data-driven industry – analytics is a key to deriving information from data.
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  - "business analytics" utilizes tools and methods for statistical analyses of data
  - "data science" can encompass broader applications in many scientific domains

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  - "business analytics" utilizes tools and methods for statistical analyses of data
  - "data science" can encompass broader applications in many scientific domains
- Analytics – the process of using data to make decisions.
  - This process involves gathering data, understanding models of uncertainty, making general inferences, and communicating results.

What is Analytics?

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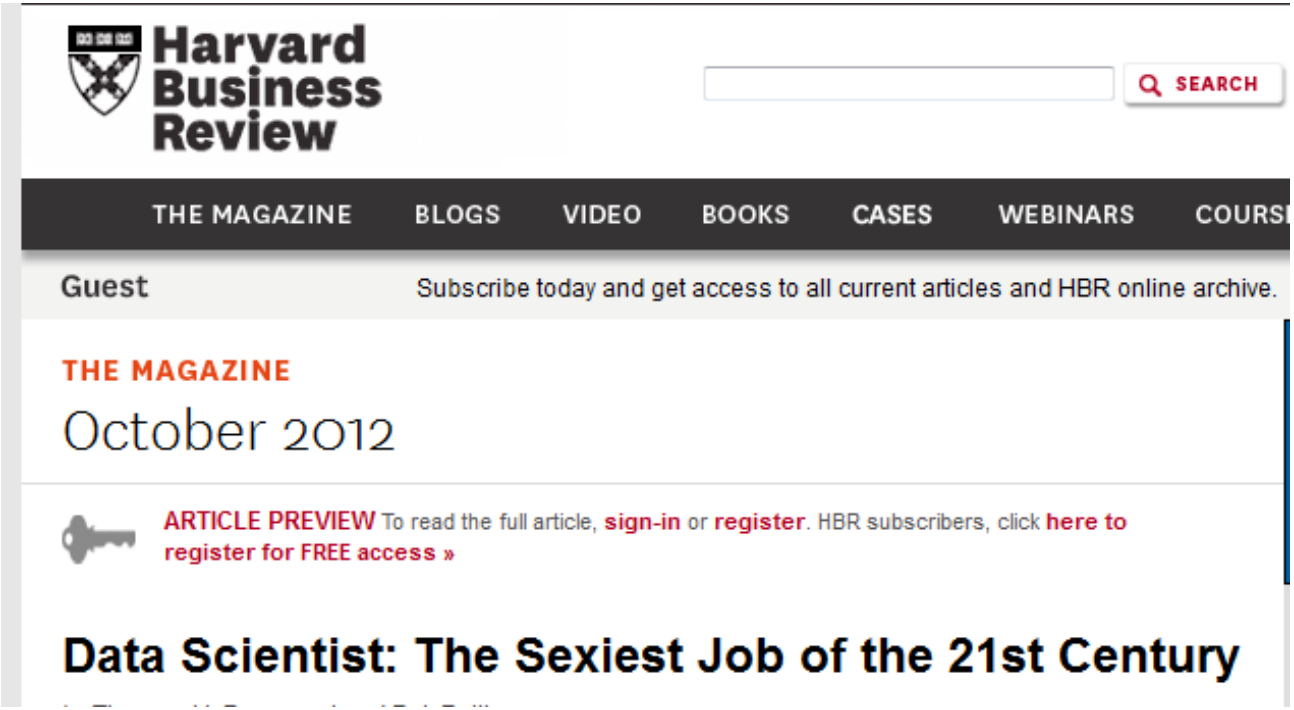
- Analytics continues to enjoy increasing popularity among businesses.

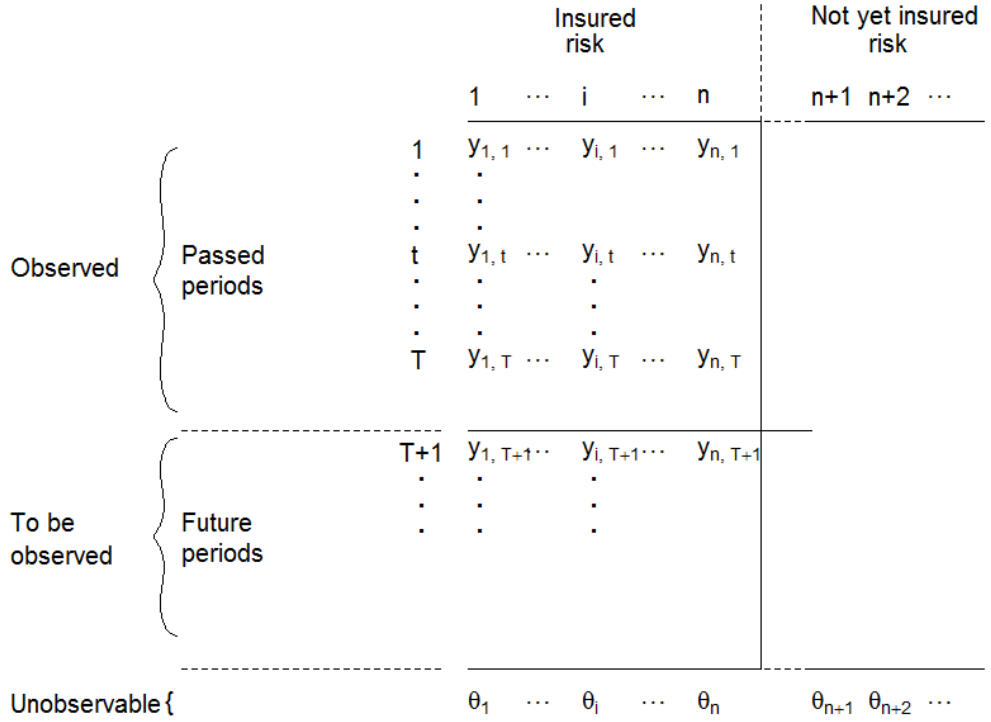


Why “Predictive”?

Why "Predictive"?

- Statisticians think about the traditional triad of inference: hypothesis testing, parameter estimation, and prediction.
- In insurance, predictions are useful for existing risks in future periods as well as not yet observed risks in a current period

Figure: Predictive Features of Insurance Analytics, Norberg (1979).



Analytics and Medical Malpractice – Motivation

- Medical malpractice, *a.k.a.* medical professional liability, is a type of insurance that provides compensation to an injured patient and families due to healthcare provider negligence
- This began as an insurance product in the late 1800's, so why do we need analytics now?

Analytics and Medical Malpractice – Motivation

- Medical malpractice, *a.k.a.* medical professional liability, is a type of insurance that provides compensation to an injured patient and families due to healthcare provider negligence
- This began as an insurance product in the late 1800's, so why do we need analytics now?
  - This line of business has small number of claims that are highly volatile $\Rightarrow$ need non-traditional analytic tools
  - This line of business is changing
    - New court cases
    - Infusion of electronic medical record systems
    - A changing business $\Rightarrow$ need non-traditional analytic tools

Wisconsin Patient Fund

Motivation - An analyst, with an academic bent, confronts a problem. What can he or she bring to the table?

Case Study - work with the Wisconsin Patient Fund.

- This is a state-sponsored fund that provides reinsurance for medical malpractice.
- Recently, a court decision has potentially lifted the limitation on the payment of non-economic benefits for, e.g., pain and suffering.

What impact will this have on the fund?

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What impact will this have on the fund?

This question is vague on purpose...

Wisconsin Medical Professional Liability (MPL) Market

Wisconsin is a middle size state, located in the middle part of the US

- Population: 5.8 million, rank 20
- GDP: 309 billion, rank 20
- P&C (NAIC) premiums: 10.3 billion, rank 22
- MPL (NAIC) premiums: 76.4 million, rank 28

Wisconsin Injured Patients Fund

- Participation is mandatory
  - For individual physicians, certified registered nurse anesthetists, and hospitals
- Coverage
  - Participants are responsible for the first layer, $1,000,000 per occurrence/$3,000,000 annual aggregate.
  - **The fund is responsible for the excess**.
- Annual assessments (premiums) are about 15 million
- Fund currently has 1.3 billion in assets

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Research Question - Suppose that Wisconsin eliminates the limitation on awards for non-economic (e.g., pain and suffering) damages. Is this a big deal?

Strategy

- Examine Literature and Industry Practice
  - History
  - International Perspective
- Take a deep dive into data available
- Step back and ask - what kind of data should be available?

Adverse Events and Medical Errors

- **Adverse events** are defined as unintended injuries or complications caused by health care management, rather than by the patient's underlying disease, that lead to death, disability or prolonged hospital stays.
  - From the influential *The Canadian Adverse Events Study*, 2006.
- **Medical error** is an unintended act or one that does not achieve its intended outcome, an error of execution, an error of planning, or a deviation from the process of care that may or may not cause harm to the patient.
  - From Makary and Daniel (2016, *British Medical Journal*) where medical error is labeled as the third leading cause of death in the US

Medical Malpractice

- Not all adverse events, nor even all medical errors, qualify as instances of **medical malpractice**.
  - There can be no malpractice without an established practice and the healthcare provider is *negligent* in failing to exercise due care.
  - There are standards of fault that must be met in determining whether negligence has occurred
- Malpractice is just one component of medical errors but represents a large amount of spending
  - Some estimate malpractice spending to be on the order of $20-50 billion USD annually.
  - Malpractice concerns give rise to **defensive medicine**, defined as the ordering of tests, referrals, and other services primarily, though not solely, to reduce liability risk; or avoidance of high-risk services or patients.

How did Medical Malpractice Suits Start in the US?

From Mohr (2000), the *Journal of the American Medical Association*

- Legal framework available from English principles, e.g., Blackstone, *Commentaries on the Laws of England* in 1768.
- First lawsuits appeared in the 1840's and well established in the 1850's.
- Lawsuits arose in part due to changes in attitudes about role of health and medicines as well as the role of professions in policing their membership.
  - For example, some prominent physicians encouraged legal action against those practicing medicine who were not well-trained nor well-educated.
  - Even the most egregious Quacks escape punishment as things now stand

prominent physician Nathan Smith, Yale University, 1827.

Why do Suits Continue? - Medical Reasons

- Medical progress. The competitive nature of the US medical marketplace is about innovation. Innovation can induce errors.
- There can be no malpractice without an established practice. The American Medical Association was founded in 1847 to regularize education and establish uniform national standards.
- Physicians pioneered the introduction of liability insurance at the end of the 1800's. With insurance, every physician was worth suing, not just the wealthy ones.

Why do Suits Continue? - Legal Reasons

- Contingent fee arrangements. As early as the 1880's, Mohr states that the AMA regarded a large proportion of malpractice actions as having
  - "no other foundation that a desire to extort money from the defendant sufficient to secure a good fee for the prosecuting counsel."
- Jury trials. Even as early as the 1850's, prominent physicians campaigned for specially empaneled expert juries, something rarely done in the US legal system.
- Tort versus contracts. As a tort, malpractice is vague, flexible, and easy to manipulate.

Chandler Case

- To emphasize the growth of malpractice awards beginning in the 1960's, one source (Yang et al. (2016)) emphasizes the Chandler case.
- Jeff Chandler was a well-known movie star in the 1950's, he stood 6' 4" and was labeled as "impossibly handsome."

Chandler Case - Continued

- He died in 1961 from complications due to a rupture in blood lining from a “routine” back surgery (aortic-iliac injury in a lumbar diskectomy procedure).
- The case was settled for $235K plus expenses. This award dwarfed other cases at the time.
  - He was well-known by the public (27 box-office successful movies) and at the prime of his career (42 years old at death).
- The case was settled by Culver City Hospital as the defendant.
  - Just before, a 1957 case altered the practice of practice of charitable immunity, switching the prime target of malpractice litigation from the physician to the more affluent hospitals.
  - Charitable immunity held that a charitable or nonprofit organization could not be held liable under tort law.

International Comparisons

Medical malpractice systems exist world-wide.

- For better or worse, medical malpractice in the US has acted as a yardstick in global debates on the topic.
- The Canadian system is less costly than the US.
- New Zealand has a no-fault system (comparable to workers' compensation
- Oliphant (2013) provide an overview of the 14 systems that also include
  - Commonwealth countries (South Africa, UK)
  - Scandinavian (that have variations of a no-fault system)
  - Other European (Poland, Italy, France, Austria, Germany)
  - Other (China, Japan, Brazil)

Canada – Less Costly Alternative

Six factors have contained the volume and cost of malpractice litigation in Canada.

- Non-economic damages for personal injury were capped by the Supreme Court of Canada in the late 1970s.
- There is no pressure to reform from physicians, because the dominant insurance scheme, overseen by the Canadian Medical Protective Association (CMPA), effectively insulates physicians from the impact of tort liability.
- The CMPA has used its deep pockets in responding to medical malpractice claims which has discouraged litigation.
- Canada's rules for awarding costs contribute to this problem, by making it risky for plaintiffs to pursue uncertain claims.
- The inherent difficulties in establishing causation in medical malpractice cases combined with the broad defenses available for physicians further exacerbate the uphill battle facing the plaintiff patient.
- The tort law system treats physicians as independent warriors shielding hospitals from vicarious liability for their malpractice.

From Flood and Thomas (2011).

US – Benchmark

Medical malpractice in the US has acted as a yardstick in global debates on the topic.

The US is different because:

- the role of the jury in deciding upon liability and assessing damages
- the availability of punitive damages
- the rule that each party bear their own legal costs, win or lose,
- the large role played by contingency fees
- the availability of extensive pre-trial procedures to require disclosure of documents and the taking of witness statements.

From Oliphant (2013).

New Zealand – No Fault System

- In New Zealand, a statutory accident compensation scheme makes provision for the payment of compensation to the victims of personal injury that is suffered in ways that are covered by the scheme.
- One of these ways is personal injury caused by medical treatment.
- From the scheme's inception, there has been a bar on suing in New Zealand for damages for personal injuries or death.
- This is a compulsory, state-controlled, scheme, funded by levies in the nature of taxation, in a field which traditionally has been the preserve of private action and initiative.

From Todd (2011).

Size of US Malpractice Awards

How big do claims get???

Bixenstine et al. (2014) in *Catastrophic Medical Malpractice Payouts in the United States*

- Defines a *catastrophic* claim to be one where the payout exceeds $1 million USD
- Uses NPDB (National Practitioners' Data Bank) over 2004-2010
  - 6,130 catastrophic payouts
  - represents 7.9% of all 77,621 reported paid claims
- The median catastrophic payout was $1,148,574, maximum was $31,744,521.
- The 7-year nationwide total of all catastrophic malpractice payouts was $9.8 billion
  - represents 36.2% of the total payouts ($27.0 billion).
  - Annually, about $1.4 billion per year.

Limitations/Caps on Damages

- In the US, the determination of liability and compensation is almost entirely the province of the civil tort system.
- Tort “reform” is favored by organized medicine, a perception that likely explains stakeholders persistent interest in pursuing damages caps and other conventional tort reforms.
- A specific type of tort reform is a limitation, or cap, on damages.

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- In the US, the determination of liability and compensation is almost entirely the province of the civil tort system.
- Tort "reform" is favored by organized medicine, a perception that likely explains stakeholders persistent interest in pursuing damages caps and other conventional tort reforms.
- A specific type of tort reform is a limitation, or cap, on damages.
- Evidence suggests (cf., Kachalia and Mello (2011)) that this is the only type of reform that has had an impact on settlements.
  - Limitations are placed on the monetary compensation that can be awarded in a malpractice trial for noneconomic losses, economic losses, or both.
  - An example of a non-economic damage award is money for "pain and suffering."

Two Recent Court Rulings

- On July 5, 2017, the Wisconsin Appellate court recently struck down the limit that caps non-economic damages in the State of Wisconsin,
  - This case may be reviewed by the Wisconsin Supreme Court. If not, it becomes state law.
- In a similar fashion, on June 8, 2017, the Florida Supreme Court struck down the limitation on capping non-economic damages for the state of Florida,

Three Data Sets

- Research Question - What is the effect of a change in the limitation on awards for non-economic damages?
- We discuss analysis of three data sets that give different insights into this question
  - *Wisconsin*. We have claims experience for the Patient Fund (reinsurer) as well as limited data for the rest of the Wisconsin marketplace.
  - *Florida*. Claims experience includes breakdown by economic and non-economic damages.
  - *Medical Liability Monitor*. A national database that provides representative premiums by specialty over time.

Wisconsin History with Non-Economic Caps on MPL

Caps on non-economic damages have varied over time

Period	Change in Cap
1975-1985	No caps in place when the fund began, July 1, 1975
1986-1991	A $1 million cap was introduced June 14, 1986
1991-1995	Cap eliminated, beginning January 1, 1991
1995-2005	$350,000 cap adjusted upward for inflation introduced May 25, 1995
2005-2006	Cap eliminated, July 15, 2005.
2006-2017	$750,000 cap introduced April 1, 2006
2017 - present	Wisconsin District 1 Appellate Court determines caps are unconstitutional (July 5, 2017)

Can we use this variation to detect changes in claiming patterns?

Wisconsin Reported Claims I

- In Wisconsin, the Patients Fund acts as the reinsurer for medical professional liability cases. As such, virtually all claims are reported to the system.
- In part because data are not regularly reviewed, the quality of the data is uneven.
  - In other databases, e.g., NPDB, claims are counted as reported only when some payment is made (indemnity or expense).
  - For this database, a claim is counted as reported if the Fund is made aware of it.

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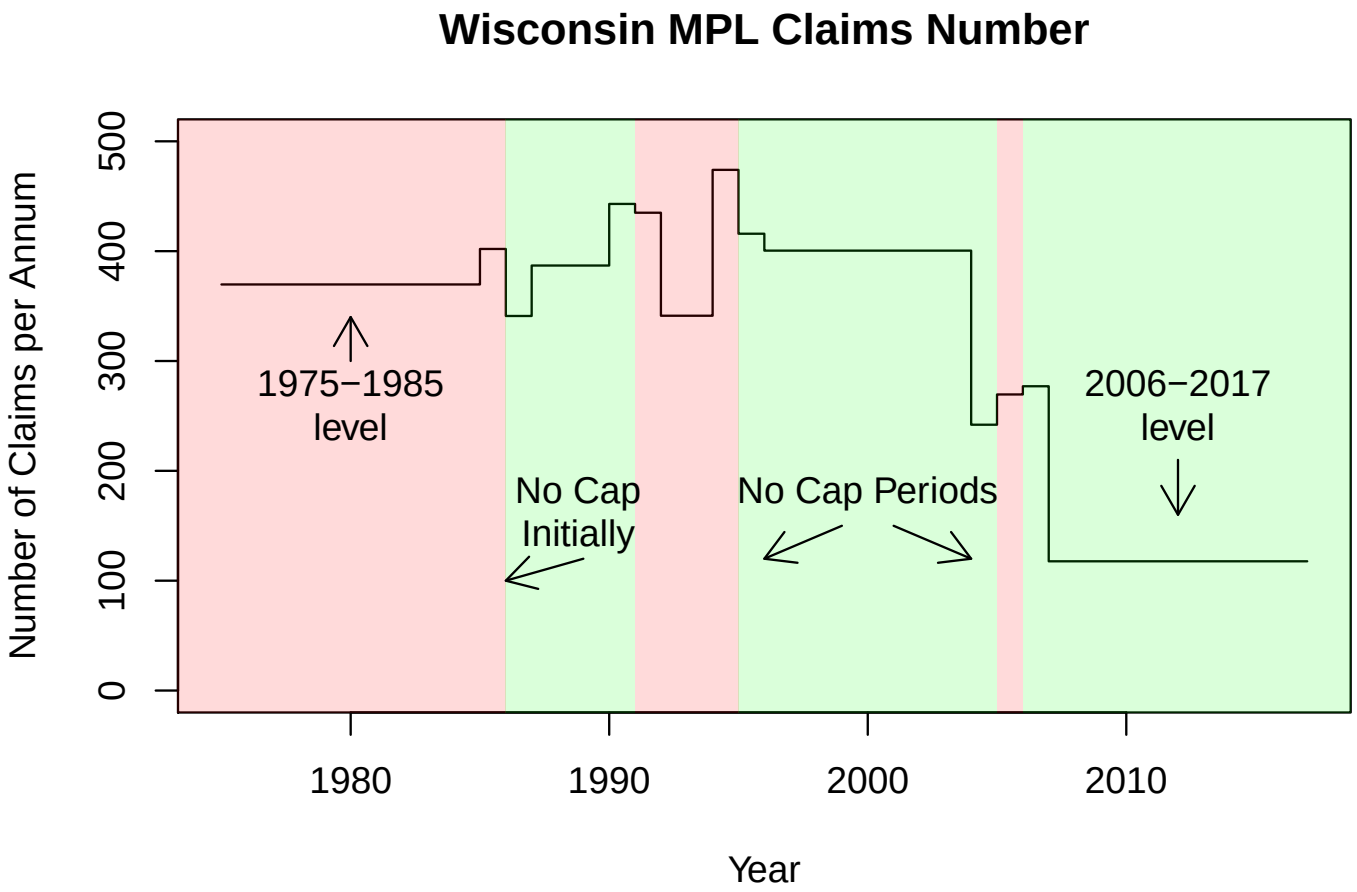
  - For this database, a claim is counted as reported if the Fund is made aware of it.
- There are 13,365 claims in this database (1975-2017)
- We split regimes into the year before a regulatory change occurred as well as a year after.

Wisconsin Reported Claims II



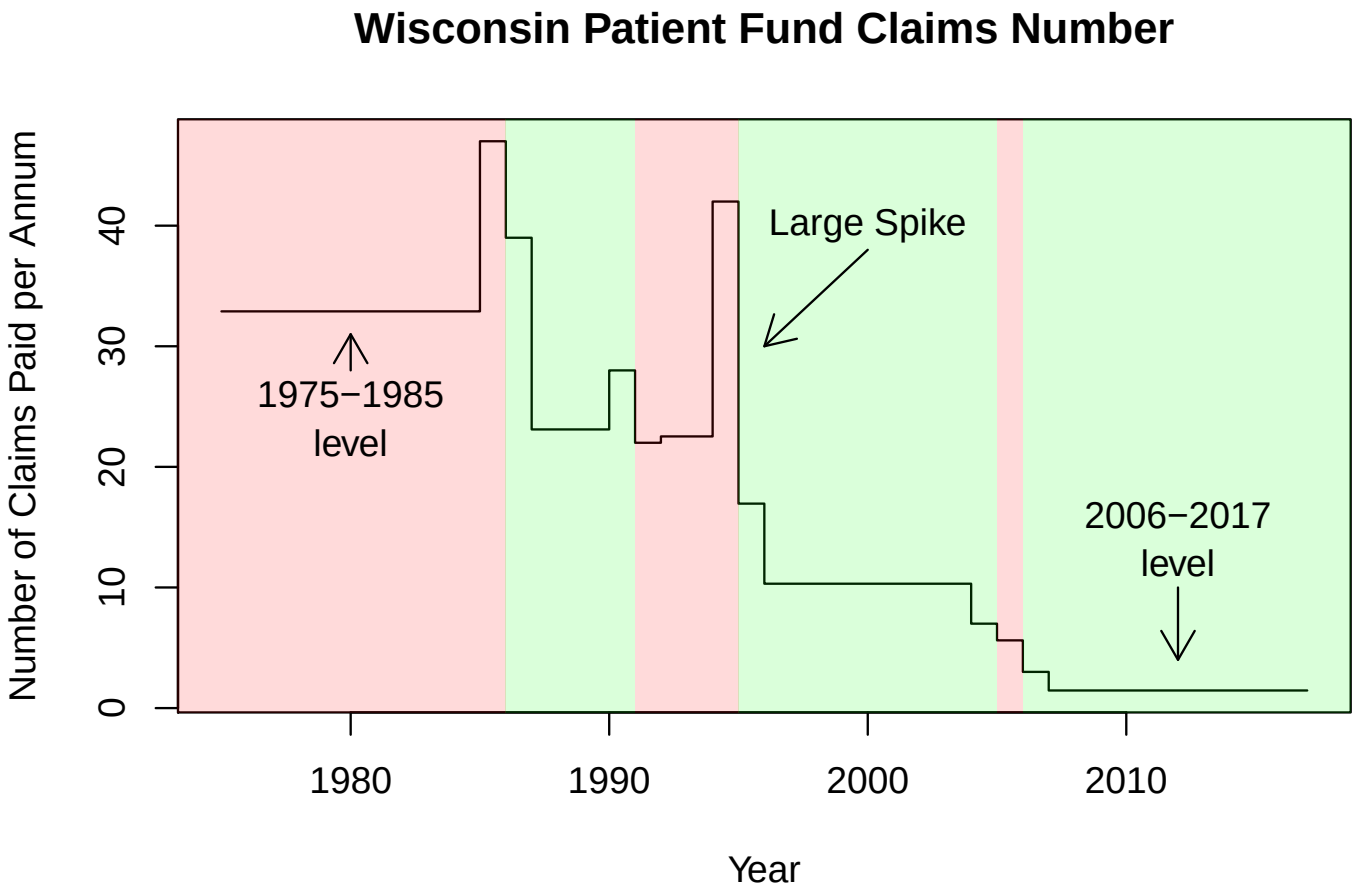
There are no dramatic changes in the number of claims surrounding the two regimes where caps were eliminated, 1991-1995 and 2005-2006.

Wisconsin Injured Patients Fund Claims

- A more disciplined method of counting claims consists of claims for which the fund made a payment.
- There are 765 such claims that total 915.2, in millions of dollars.
- The attachment point at which fund payments are made has varied over time.

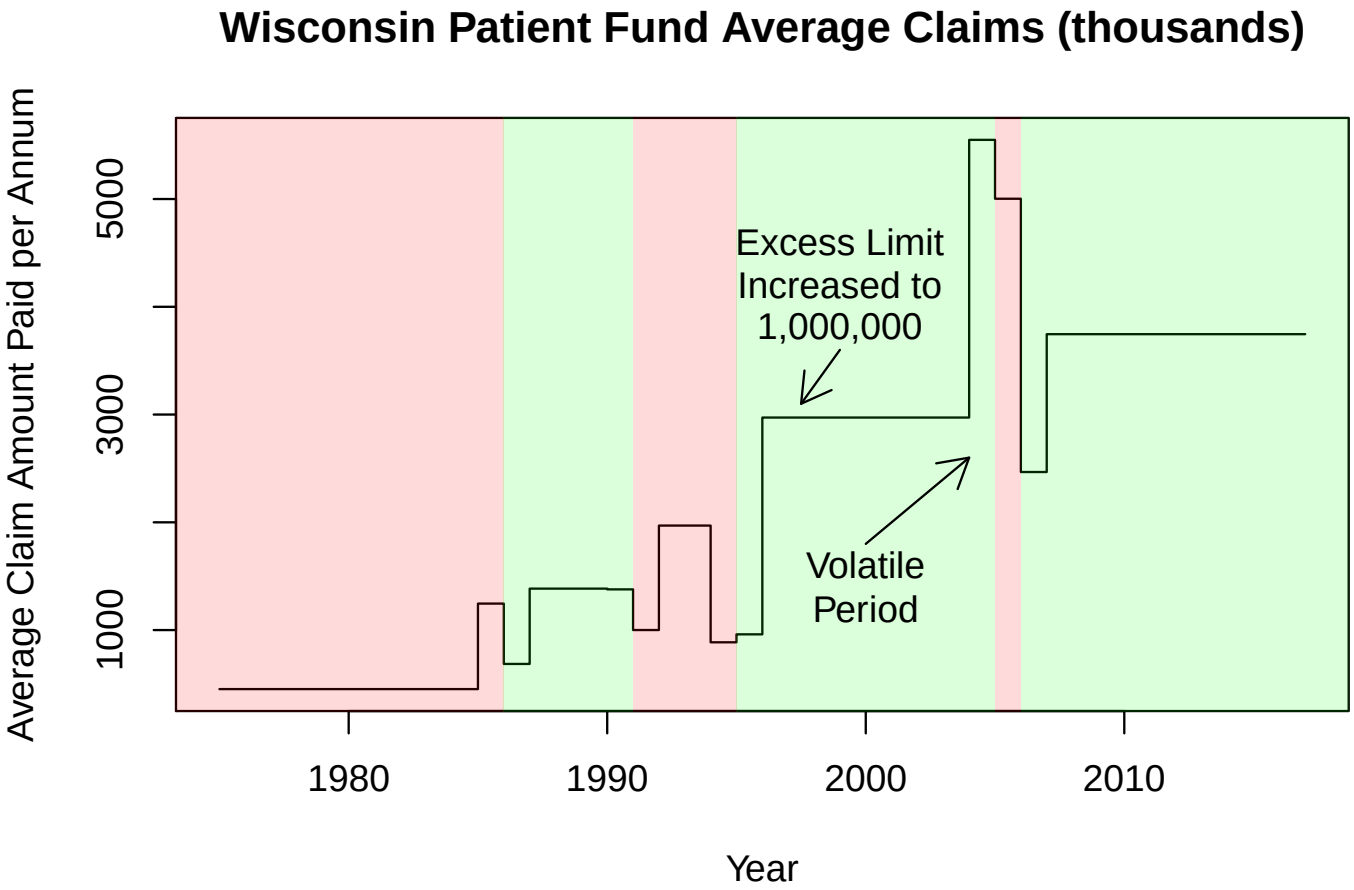
Period	**Fund Payment Obligations** *Fund pays damages in excess of:*
1975-1987	$200,000 ($600,000 aggregate) until July 1, 1987
1987-1988	$300,000 ($900,000 aggregate) until July 1, 1988
1988-1997	$400,000 ($1,000,000 aggregate) until July 1, 1997
1997-present	$1,000,000 ($3,000,000 aggregate)

Patient Fund Number of Claims



There was substantial volatility following the end of the periods in which caps were eliminated in 1986 and 1995 although not 2006.

Patient Fund Average Claim Amounts



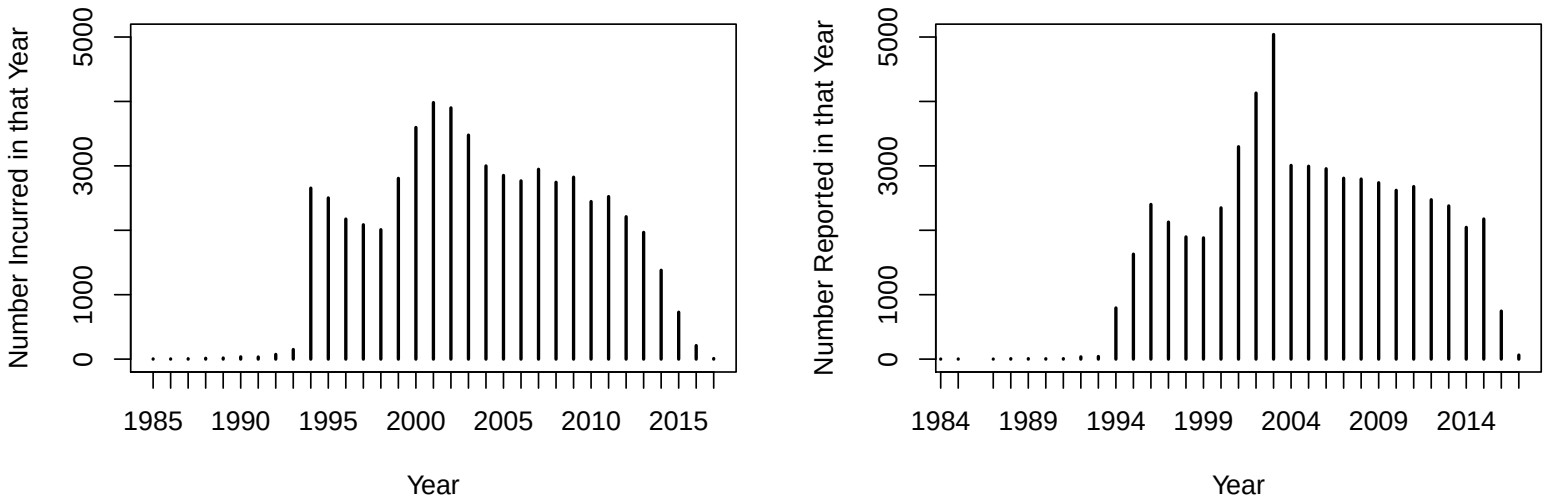
For years surrounding the regime 2005-2006 when caps were eliminated, the typical (average) damage size is larger compared to surrounding years.

Florida Database

- Florida is one of two US States that maintains a database containing medical malpractice claims
  - The only database to provide a split on economic versus non-economic damages
  - PIAA, NPDB, NAIC, Texas do not
- Cap applies to any medical incident for which a notice of intent to initiate litigation is mailed on or after September 15, 2003

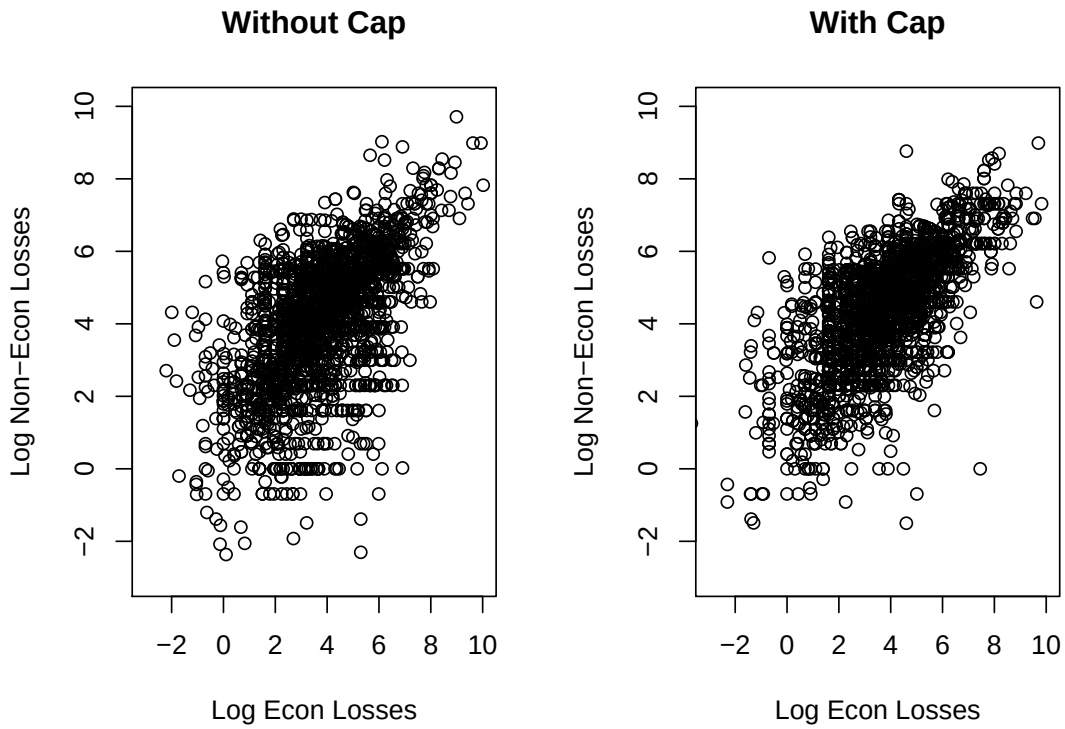
Limitations	**Provider Type**
$150,000 claimant ($300,000 aggregate)	emergency room practitioners
$750,000 claimant ($1.5 million aggregate)	emergency room facilities
$750,000 claimant ($1.5 million aggregate)	non-practitioners

Florida Number of Claims



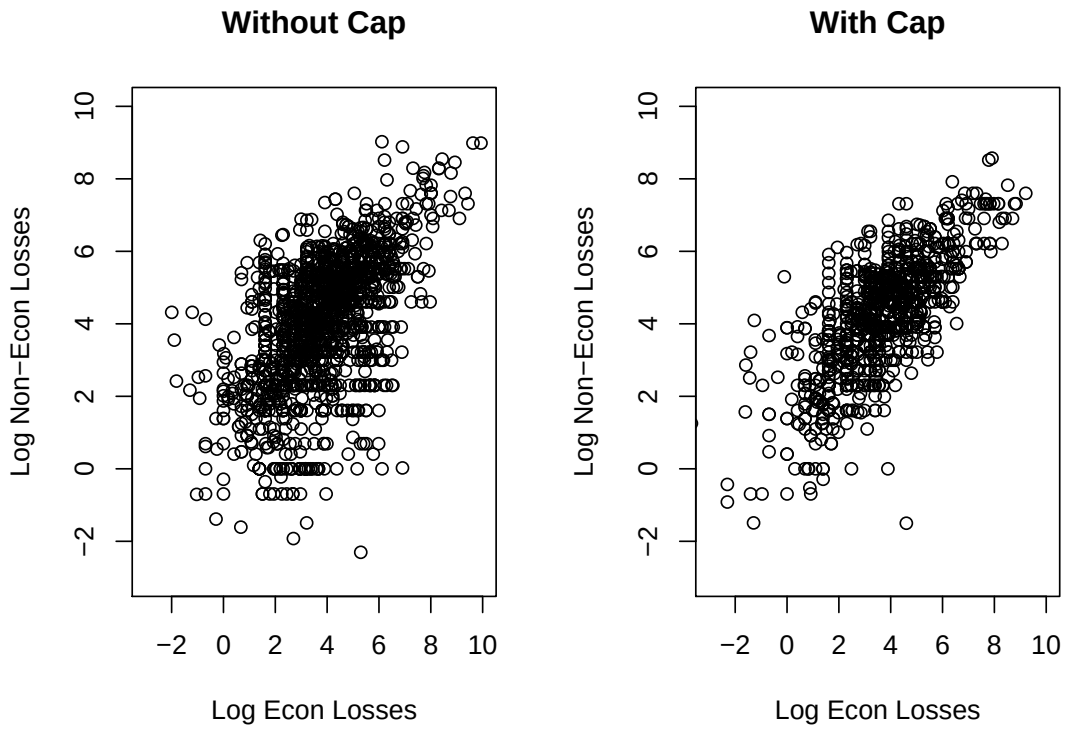
- The left-hand panel shows no dramatic changes in the number of incidents around 2003.
- The right-hand panel shows a spike in the number of claims reported around 2003.

Economic vs Non-Economic Claims



- These plots compare economic to non-economic damages (on a logarithmic scale)
- Left-hand panel is before Sept, 2003 (without cap); right-hand panel is after Sept, 2003
- Not much difference in the two regimes

Economic vs Non-Economic - Five Years



- Here are the same variables but limited to data five years before and after 15 Sept 2003
- Left correlation (Spearman) is 0.57, right 0.70; slightly stronger
- We do not see substantial differences in the two regimes

Limitations of Florida Data

- Analysis is based on 5,226 claims that had positive damages
- As noted in the Florida annual Medical Malpractice Report
  - “Some companies did not segregate payments between economic and non-economic loss.”
  - “... the majority of claims are settled out of court. Often, these settlements stipulate a flat payment to the plaintiff and do not distinguish what portion of the payment by the insurer is for economic versus non-economic damages.”
- Limitation - database does not include policy limits (unlike Texas).
  - “As a practical matter, the stakes in malpractice suits are capped by the limits of physicians’ insurance coverage, regardless of the severity of patients’ injuries or the amounts that juries believe patients ought to receive.”
- The removal of a cap may have a smaller effect in Florida, where insurers limit coverages, compared to Wisconsin that provides unlimited coverage.

Additional Work Needed for Florida Data

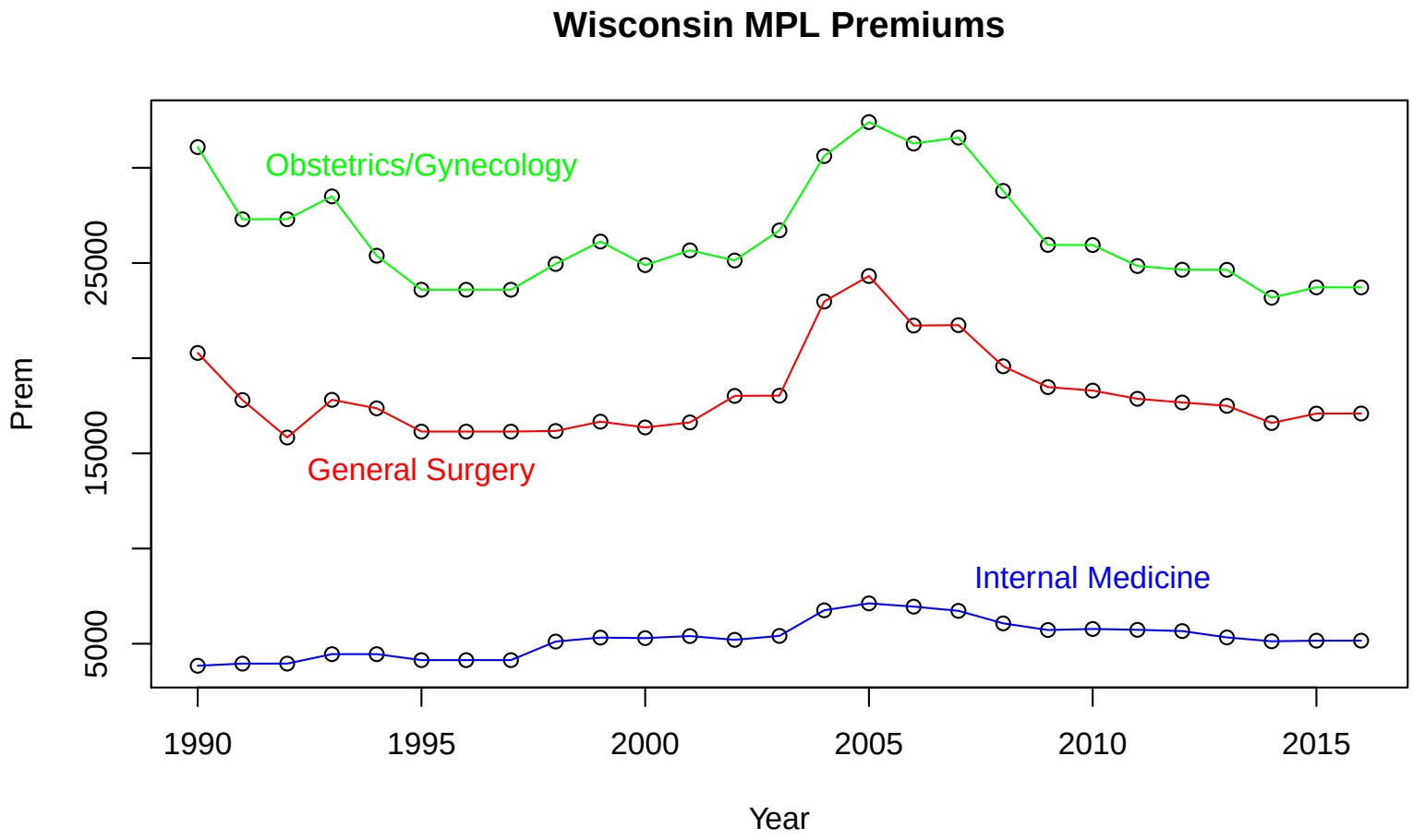
- The Florida database provides additional explanatory information regarding the:
  - Incident (County Injury Occurred, Date Injury Occurred, Date Injury Reported, County Suit Filed)
  - Plaintiff (Injury Severity)
  - Defendant (Insurer Type, Licensed Insurer Name)
  - Settlement (Court Decision, Final Disposition, Date Final Disposition, Date Submitted)
- In principle, use these characteristics as well as
  - exposure information (e.g., number of physicians by specialty) and
  - time trends (e.g., inflation)

to tease out differences between cap and non-cap distributions

Effect of Damage Caps on Premiums

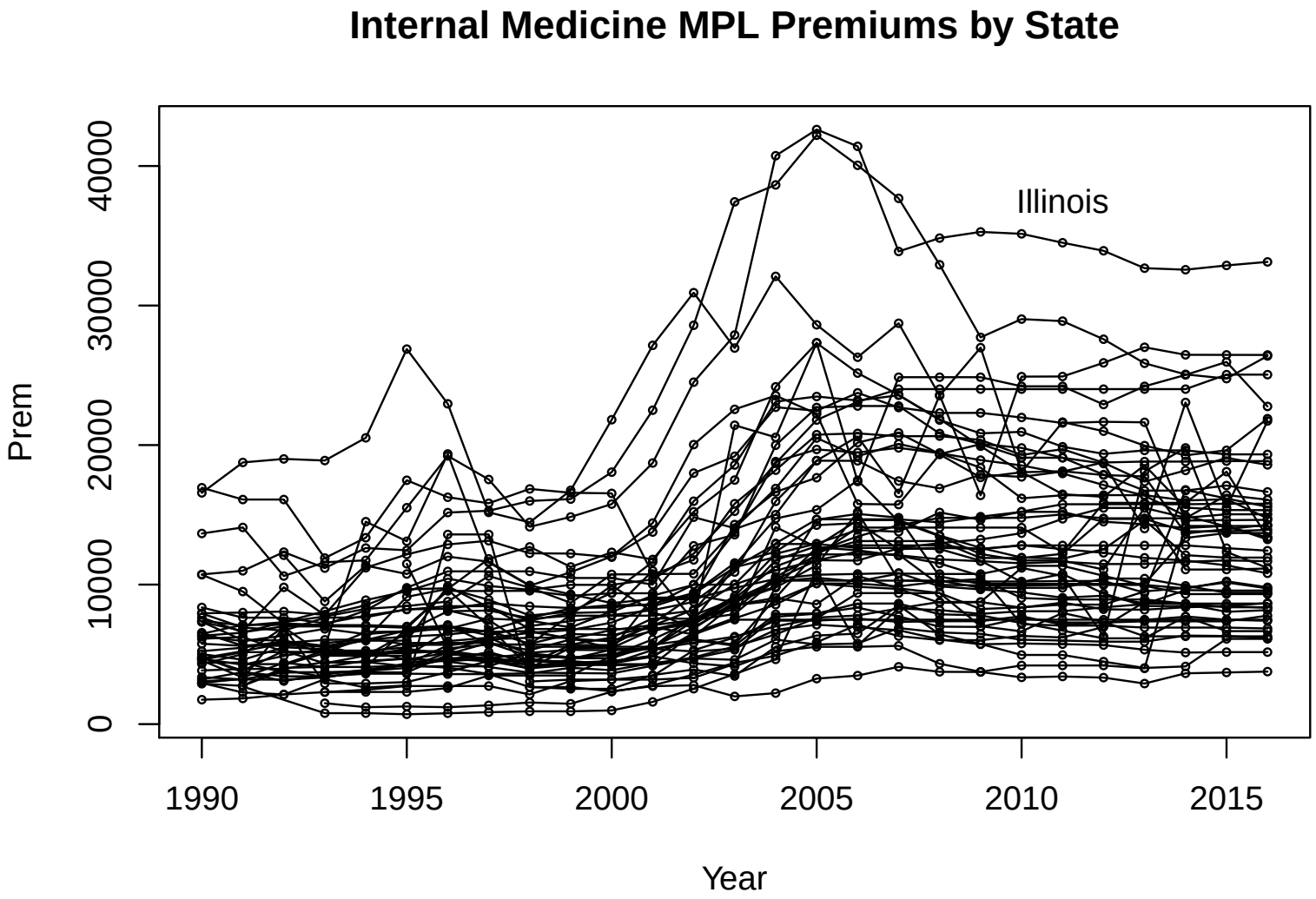
- Assess the effect that a damage cap has on premiums paid by healthcare providers medical professional liability insurance.
  - Goal - stabilize the marketplace so that healthcare providers have access to affordable insurance coverage.
- To quantify this, *Medical Liability Monitor (MLM)* has conducted a survey annually since 1990 on premiums paid by physicians in selected specialities.
- Kilgore et al. (2006) - 1991-2004 data
  - found damage caps predict lower med mal premia, and the stricter the cap, the lower the premia.
- Nelson et al. (2011) - 1991-2004 data
  - med mal premia grow more slowly and are less volatile in states with damage caps in effect.
- Black et al. (2017) linked MLM to other data sources from the NAIC and the American Medical Association.

Wisconsin MPL Premiums by Specialty



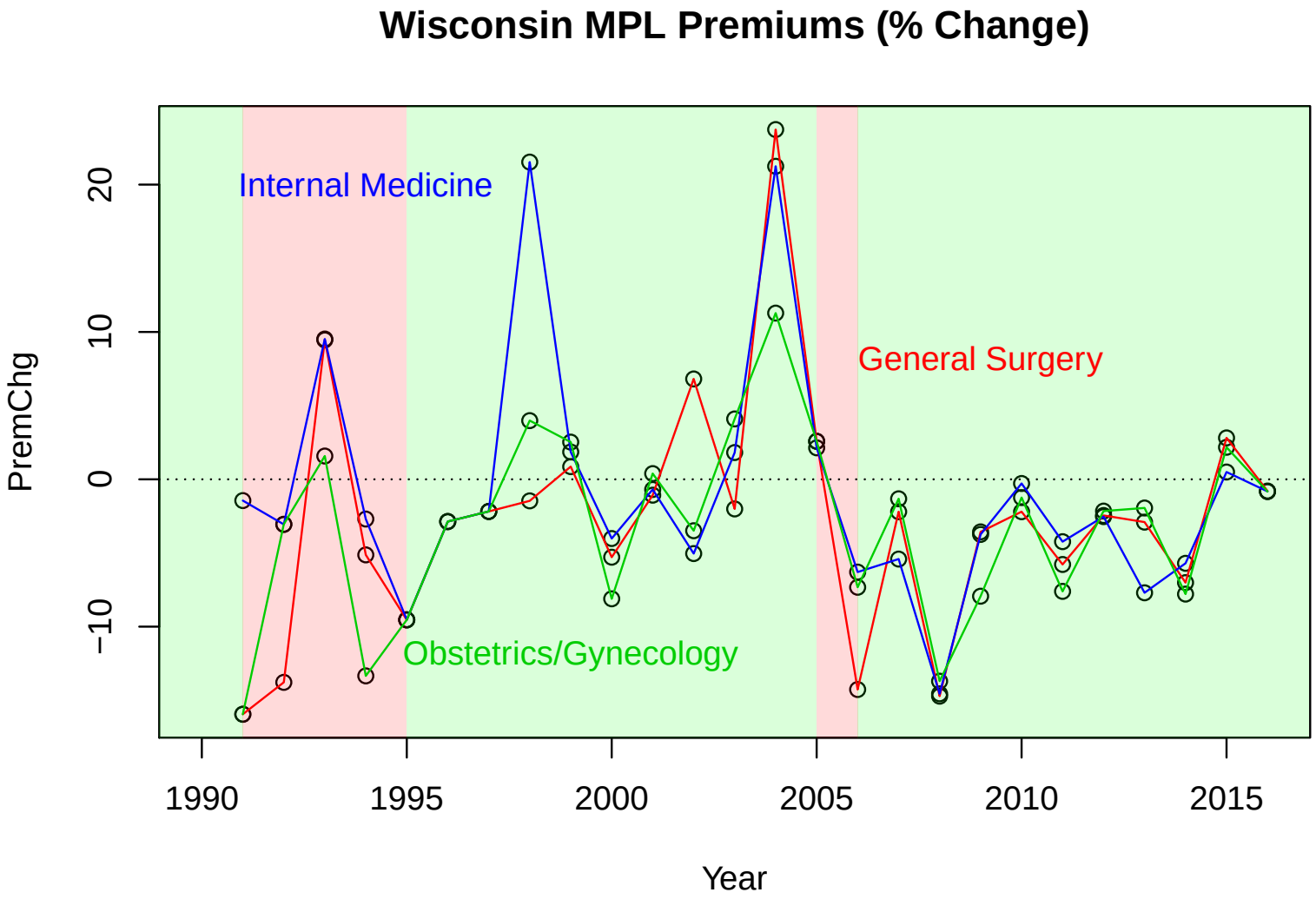
- Differences among specialities are important

Internal Medicine MPL Premiums by State



- Even within a specialty, differences among states are important

Wisconsin MPL Premium Changes



- More volatility before 2005
- Difficult to detect important price changes due to caps

MPL Premium Findings

Consistent with earlier studies, we find that damage caps impact premiums paid by physician

- Our estimates of the magnitude and timing differ
- Distribution of premium changes seems to be more peaked than suggested by a normal curve (thinner tails) - we are examining alternative distributions
- Strong relation among specialties even after controlling for other variables. We are using copula models to account for this association.

Needed – Data

- Experience varies tremendously by state due to different (i) medical, (ii) legal, and (iii) insurance environments.
- Further, experience from each state is limited.
- With a common data system, we could compare and contrast different state experiences and learn more
  - NAIC model law (2010) provides one framework for producing a standard dataset
  - National Practitioner's Data Bank codes many, but not all, of these data elements
- Mello and Studdert (2016) call for developing a national data surveillance system for tracking medical malpractice claims
  - "a missed opportunity to improve patient safety and better understand the performance of the medical liability system"

Goals of a Medical Malpractice System

Medical malpractice systems exist world-wide. What are their goals?

- **Prevention.** The prevention of medical injuries and the promotion of patient safety are paramount goals of health care policy. The prospect of liability in damages acts as an incentive to act with reasonable care.
- **Compensation.** Compensation of injured patients is a core function of the law regarding medical malpractice and medical injuries
- **Accountability.** Injured patients want to know what went wrong, who was responsible for it, what efforts are being made to prevent future repetitions, and to receive an admission of fault and an apology.

Summary and Conclusions

- Use data to make decisions – analytics
- Ask questions about prevailing practice, about history, about seemingly different regions/practice areas
- Examine the data with a purpose. But, be willing to think about different purposes
- Technical analysts traditionally give precise answers to approximate questions. Be willing to give approximate answers to questions of interest.
- In searching for the right question, think about what type of information/data you would like to have.

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Thank you for your time and attention.

References

Avraham, Ronen (2007). "An empirical study of the impact of tort reforms on medical malpractice settlement payments," *The Journal of Legal Studies*, Vol. 36, pp. S183–S229.

Bixenstine, Paul J., Andrew D. Shore, Winta T. Mehtsun, Andrew M. Ibrahim, Julie A. Freischlag, and Martin A. Makary (2014). "Catastrophic medical malpractice payouts in the United States," *Journal for Healthcare Quality*, Vol. 36, pp. 43–53.

Black, Bernard, Jeanette W. Chung, Jeffrey Traczynski, Victoria Udalova, and Sonal Vats (2017). "Medical liability insurance premia: 1990–2016 Dataset, with literature review and summary information," *Journal of Empirical Legal Studies*, Vol. 14, pp. 238–254.

Born, Patricia and Faith Roberts Neale (2014). "The differential effects of noneconomic damage cap levels on medical malpractice insurers," *Risk Management and Insurance Review*, Vol. 17, pp. 163–181.

Danzon, Patricia (1984). "The frequency and severity of medical malpractice claims," *The Journal of Law and Economics*, Vol. 27, pp. 115–148.

Danzon, Patricia M. (1986). "The frequency and severity of medical malpractice claims: New evidence," *Law and Contemporary Problems*, Vol. 49, pp. 57–84.

Durrance, Christine Piette (2009). "Noneconomic damage caps and medical malpractice claim frequency: A policy endogeneity approach," *The Journal of Law, Economics, & Organization*, Vol. 26, pp. 569–591.

Flood, Colleen M and Bryan P Thomas (2011). "Canadian medical malpractice law in 2011: missing the mark on patient safety," *Chicago-Kent Law Review*, Vol. 86.

Friedson, Andrew I. (2017). "Medical malpractice damage caps and provider reimbursement," *Health Economics*, Vol. 26, pp. 118–135.

Kachalia, Allen and Michelle M. Mello (2011). "New directions in medical liability reform," *The New England Journal of Medicine*, Vol. 364, p. 1564.

Kessler, Daniel P. and Mark B. McClellan (2002). "How liability law affects medical productivity," *Journal of Health Economics*, Vol. 21, pp. 931–955.

Kilgore, Meredith L., Michael A. Morrisey, and Leonard J. Nelson (2006). "Tort law and medical malpractice insurance premiums," *Inquiry: The Journal of Health Care Organization, Provision, and Financing*, Vol. 43, pp. 255–270.

Mello, Michelle M. and David M. Studdert (2016). "Building a national surveillance system for malpractice claims," *Health Services Research*, Vol. 51, pp. 2642–2648.

Mohr, James C. (2000). "American medical malpractice litigation in historical perspective," *Journal of the American Medical Association*, Vol. 283, pp. 1731–1737.

Muhlestein, David B., Abigail Shoben, and Thomas Wickizer (2016). "Caps on noneconomic damages' effect on the number of paid malpractice claims in various American states," *International Journal of Healthcare*, Vol. 2, p. 45.

Nelson, Leonard J., Michael A. Morrisey, and David J. Becker (2011). "Medical liability and health care reform," *Health Matrix*, Vol. 21, pp. 443–519.

Paik, Myungho, Bernard Black, and David A. Hyman (2017). "Damage caps and defensive medicine, revisited," *Journal of Health Economics*, Vol. 51, pp. 84–97.

Seabury, Seth A., Eric Helland, and Anupam B. Jena (2014). "Medical malpractice reform: Noneconomic damages caps reduced payments 15 percent, with varied effects by specialty," *Health Affairs*, pp. 10–1377.

Silver, Charles, Kathryn Zeiler, Bernard S. Black, David A. Hyman, and William M. Sage (2008). "Malpractice payouts and malpractice insurance: Evidence from texas closed claims, 1990–2003," *The Geneva Papers on Risk and Insurance-Issues and Practice*, Vol. 33, pp. 177–192.

Sloan, Frank A. (1985). "State responses to the malpractice insurance "crisis" of the 1970s: An empirical assessment," *Journal of Health Politics, Policy and Law*, Vol. 9, pp. 629–646.

Todd, Stephen (2011). "Treatment injury in New Zealand," *Chicago-Kent Law Review*, Vol. 86, p. 1169.

Yang, Brian W., Wenya Linda Bi, Timothy R. Smith, Ryan Brewster, William B. Gormley, Ian F. Dunn, and Edward R. Laws (2016). "How a lumbar diskectomy influenced medical malpractice and the landscape of health care," *World Neurosurgery*, Vol. 86, pp. 88–92.

Yoon, Albert (2001). "Damage caps and civil litigation: An empirical study of medical malpractice litigation in the South," *American Law and Economics Review*, Vol. 3, pp. 199–227.

Zuckerman, Stephen, Randall R. Bovbjerg, and Frank Sloan (1990). "Effects of tort reforms and other factors on medical malpractice insurance premiums," *Inquiry*, pp. 167–182.

Appendix - Patient Compensation Funds

- To help manage the Medical Professional Liability (MPL) marketplace, nine states have Patient Compensation Funds (PCFs)
  - Goal 1: provide physicians an excess layer of coverage and thus decreases the volatility in losses
  - Goal 2: ensure that sufficient funds are available to provide compensation for injured patients
- You can think of these funds as acting as reinsurers for the MPL market
  - Every PCF state requires physicians to carry primary medical malpractice liability insurance
  - Fund participation is mandatory in only three states: Kansas, Pennsylvania, and Wisconsin
  - Wisconsin is the only state where fund liability is **unlimited**

Patient Fund Comparison

STATE	Primary Carrier Requirements		Fund Coverage Limits	
	Per Occurrence	Annual Aggregate	Per Occurrence	Annual Aggregate
Indiana	250,000	750,000	1,000,000	
Kansas	200,000	600,000	100,000	300,000
			300,000	900,000
			800,000*	2,400,000*
Louisiana	100,000	300,000	400,000	
Nebraska	500,000	1,000,000	1,750,000	
New Mexico	200,000	600,000	400,000	
New York	1,300,000	3,900,000	1,000,000	3,000,000
Pennsylvania	500,000	1,500,000	500,000	1,500,000
South Carolina	200,000	600,000	Variable**	Variable**
Wisconsin	1,000,000	3,000,000	**Unlimited**	**Unlimited**

*Most physicians in Kansas opt for the largest coverage choice
**South Carolina is similar to Kansas but with more options

Medical Professional Liability Tort Reforms

Reform	Description
Caps on damages	Limitations are placed on the monetary compensation that can be awarded in a malpractice trial for noneconomic losses, economic losses, or both.
Screening panels	Expert panels review malpractice cases at an early stage and provide opinions about whether claims have sufficient merit to proceed.
Certificate of merit	The plaintiff must present, at the time of filing a malpractice claim or soon thereafter, an affidavit certifying that a qualified medical expert believes that there is reasonable and meritorious cause for the suit.
Limits on attorney fees	Limitations are placed on the amount that a plaintiff's attorney may take as a contingency fee. A limitation is typically expressed as a percen1tage of the award, but it may also incorporate a maximum dollar value.
Joint and several liability (JSL)	In malpractice trials involving multiple defendants, JSL reform limits the financial liability of each defendant to the percentage of fault that the jury allocates to that defendant. Without this statutory reform, a plaintiff may collect the entire judgment from one defendant, regardless of that defendant's extent of fault in the case.
Collateral source rule	This reform eliminates a traditional rule that even if an injured plaintiff has received compensation from other sources (e.g., health insurance), the amount should not be deducted from the amount that a defendant who is found liable must pay.
Periodic payment	This reform allows or requires insurers to pay malpractice awards over a long period of time rather than in a lump sum. Insurers are also able to retain any amount that is not collected during a plaintiff's lifetime.
Statute of limitations	These statutes limit the amount of time that a patient has to file a malpractice claim after being injured or discovering an injury.

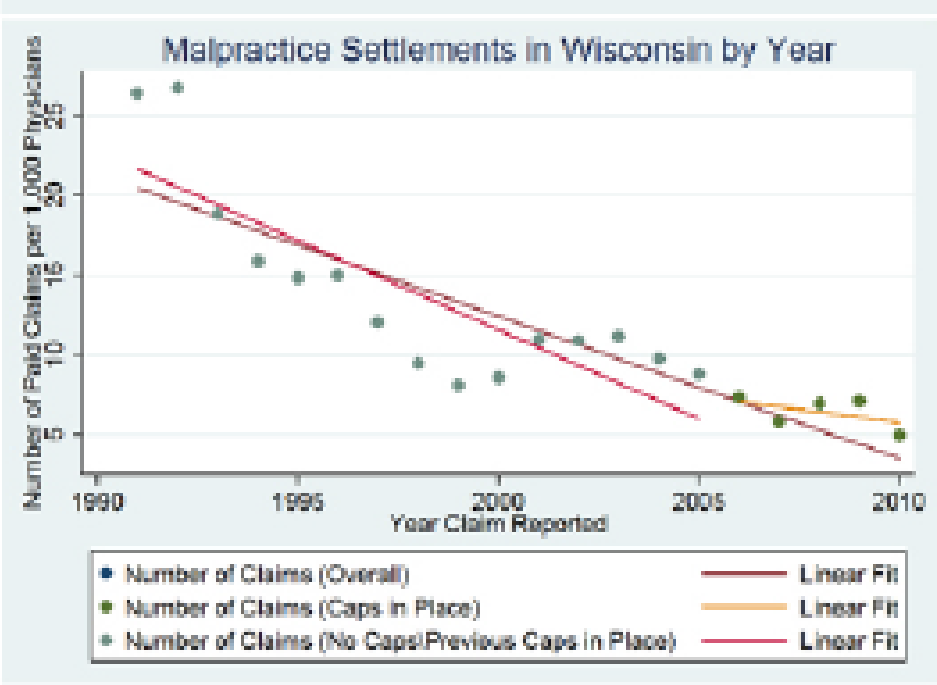
Source: Kachalia and Mello (2011)

Effects of Damage Caps on Claims Frequency

- Several studies have found that the adoption of liability reform lowers the probability of physicians experiencing a malpractice claim, Avraham (2007), Danzon (1986), Kessler and McClellan (2002)
- Others have found no effect Danzon (1984), Zuckerman et al. (1990), Durrance (2009)
- Muhlestein et al. (2016) in *Caps on Noneconomic Damages' Effect on the Number of Paid Malpractice Claims in various American States*
  - Of the 15 states that implemented caps on noneconomic damages or significantly changed their caps since 2000, only two had significant changes in the number of paid claims (intercept) and six had significant changes to their trend of paid claims (slope).
  - Uses NPDB (National Practitioners' Data Bank)

Wisconsin NPDB Number of Claims

Wisconsin, which raised its caps, did not see a significant increase in the rate of paid claims.



Based on NPDB data – ignores hospital claims.

Effects of Damage Caps on Claims Severity

- Several studies have found that limitations on allowable damage recovery, particularly for noneconomic damages, reduce the average size of malpractice payments. Avraham (2007), Danzon (1984), Danzon (1986), Sloan (1985), Yoon (2001).
- Others have found no effect. Zuckerman et al. (1990), Durrance (2009)
- Seabury et al. (2014) in *Medical Malpractice Reform: Noneconomic Damages Caps Reduced Payments 15 Percent, With Varied Effects By Specialty,*
  - Found that a cap reduces average payments by 15%, with the reduction varying by the size of the cap.
  - Study uses PIAA (Physicians Insurers Association of America) data over 1985-2010; has information on hospital claims.
  - They were able to control for the physician specialty, an advantage compared to NPDB.
  - Limitation - No information on exposure/frequency of claims.

Effects of Damage Caps on Other Measures

- Born and Neale (2014) in *The Differential Effects Of Noneconomic Damage Cap Levels On Medical Malpractice Insurers,* study the effects of caps on insurance performance.
  - Here, direct losses incurred and the loss ratio are measures of performance
  - They use NAIC data from 1997 to 2007 and consider several types of caps and of varying degrees
- Friedson (2017) in *Medical Malpractice Damage Caps And Provider Reimbursement,* estimate the effect of damage caps on the amount providers charge to insurance companies as well as the amount that insurance companies reimburse providers for medical services.
- Paik et al. (2017) in *Damage Caps and Defensive Medicine, Revisited,* examines effects on Medicare spending for hospital care
- Others...

Relating Caps on Damages to Policy Limits

- Silver et al. (2008) in *Malpractice Payouts and Malpractice Insurance: Evidence from Texas Closed Claims, 1990-2003*.
  - Texas is the only (publicly available) source that captures information on limits on coverage of a medical professional liability insurance policy.
  - "As a practical matter, the stakes in malpractice suits are capped by the limits of physicians' insurance coverage, regardless of the severity of patients' injuries or the amounts that juries believe patients ought to receive."
- Several studies have established that the imposition of a cap has some (but limited) impact on the amounts paid. However, for Wisconsin, the situation may be more dire....