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Medical Malpractice and Physician Liability Under a Negligence Rule

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Abstract

A model of costly medical malpractice claims, based on Bayes Rule, is developed to examine the effects of physicians being liable for actual damage under a negligence rule. This model is consistent with empirical evidence concerning the pattern of claims. It is shown that compensating actual damage does not provide physicians with appropriate incentives to spend the second best optimal amount of time with patients or to treat the second best optimal number of patients. As a result, too much medical malpractice occurs relative to the second best social optimum.

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1 Introduction

Numerous empirical studies have found surprisingly large rates of medical malpractice. The Californian Medical Association (1977) using Californian hospital data found 1 in 125 patients suffered a negligent medical injury while Weiler et. al. (1993) using New York hospital data found 1 in 100 patients suffered a negligent medical injury. These large rates occurred despite physicians being liable for damage under a negligence rule. In addition, they are inconsistent with the theoretical prediction of Shavell (1980) that under a negligence rule all physicians undertake "due care" and as a result there is no medical malpractice, Danzon (1991). The main innovation in this paper is the modeling of a patient's medical malpractice claim decision which when coupled with physician liability for actual damage provides weak incentives for physicians to spend the optimal amount of time with patients and to treat the optimal number of patients. These weak incentives result in too much medical malpractice.

In this paper, as in Arlen and MacLeod (2005), medical malpractice is defined as an incorrect diagnosis or treatment that occurs with some positive probability, where this probability depends on the quality of the service provided. In turn, physician quality of service depends on the amount of time a physician spends with each patient. An implication of this approach is that the optimal probability of medical malpractice occurring is non-zero. It is just too costly in terms of physician dis-utility of time to eliminate medical malpractice completely.

However, unlike Arlen and MacLeod, who implicitly assume that whenever an incorrect decision is made and damage occurs that a claim for medical malpractice is instigated and is successful in court, this paper formally models the claim decision. It is assumed that patients know the probability distributions over health outcomes conditional on correct and incorrect physician decisions. On observing their health outcomes, patients use Bayes Rule to determine the probability that an incorrect decision was made. This probability is converted into a probability of winning a claim and a claim is made if the expected payout from a claim is greater than the cost of a claim.

It is shown in Section 4.2 that there exists a payment, for which the physician is liable when a successful medical malpractice claim is made, that results in physicians choosing the second best optimal amount of time to spend with patients and treating the second best optimal number of patients. This payment is similar to that found in Arlen and MacLeod (2005). It is the difference between the monetary values of the expected health outcomes under the correct and incorrect decisions scaled up by the reciprocal of a probability plus an amount equal to the cost of a claim. In this paper, this probability is the probability that a patient makes a claim, given an incorrect decision is made, and comes from a model of medical malpractice claims, while in Arlen and MacCleod it is the exogenous probability that actual damage occurred.[1]

The problem with this payment is that it is paid whenever medical malpractice is demonstrated regardless of the amount of actual damage done. Tort law has two basic objectives, the first is to deter misconduct or errors and the second is to compensate victims for any damage inflicted. The optimal payment above achieves the first objective, but not the second. In practice, courts compensate patients for actual damage as this is what is observed. In Section 4.3 it is shown that where actual damage is compensated,

[1] In Polinsky and Shavell (1998) this probability is the probability of being found liable by a court.

expected actual damage is less than the difference between the monetary values of the expected outcomes under the correct and incorrect decisions adjusted for the cost of a claim. Therefore, compensating actual damage does not provide strong enough incentives for physicians to spend the second best optimal amount of time with patients and to treat the second best optimal number of patients. As expected, under a negligence rule, there is a tension between the two objectives of tort law. Either second best optimal incentives can be provided or actual damage is compensated, not both.

The model developed in this paper yields results that are consistent with several empirical findings summarised in Danzon (1991). (1) a relatively large rate of medical malpractice, (2) a small number of claims, (3) medical malpractice occurs, but no claim is made, (4) a claim is made, but no medical malpractice occurs, and (5) only the most valuable claims are made.

2 Model Set-Up

A physician can make the correct diagnosis or implement the correct treatment, C, with probability Π and make an incorrect diagnosis or implement an incorrect treatment, M, with probability $(1-\Pi)$. M is interpreted as medical malpractice. If the correct decision is made, the benefit, b, the patient receives from treatment is distributed with density $f(b|C)$ and cumulative distribution $F(b|C)$ over $[\alpha_c, \beta_c]$. If an incorrect decision is made, then patient benefit is distributed according to $f(b|M)$ and $F(b|M)$ over $[\alpha_m, \beta_m]$. It is assumed that $\alpha_m \leq \alpha_c$, $\beta_m \leq \beta_c$, and that $F(b|C)$ first-order stochastically dominates $F(b|M)$. As a result, the expected benefit of the correct treatment, E_C, is greater than the expected benefit of an incorrect treatment, E_M, that is $E_C > E_M$.

The probability of a physician making the correct decision depends on the quality of the service the physician provides, q. In turn, quality depends on the amount of time the physician spends in taking and updating medical histories, examination, diagnosis, and treatment, t.[2] Therefore, $\Pi\big(q(t)\big)$ or $\Pi(t)$. It is assumed that the latter function is increasing and strictly concave. The more time a physician spends with the patient the less likely is a physician to make an incorrect decision. This set-up is essentially that of Arlen and MacLeod (2005) with more attention given to the distributions of possible outcomes.

2.1 Patients

All patients are assumed identical and so have the same density and distribution functions over the benefits from treatment. The expected benefit a patient receives from treatment by a physician is given by

$$\begin{aligned} B(t) &= \Pi(t) \cdot E_C + \big(1 - \Pi(t)\big) \cdot E_M \\ &= E_M + \Pi(t) \cdot (E_C - E_M) \end{aligned} \tag{1}$$

It is assumed that patients are fully publicly insured and so do not directly pay for physician services. In addition, it is assumed that physicians are paid by the public insurer.

2.2 Physicians

The number of physicians is fixed at N. All physicians are assumed to be risk neutral and only value income. The representative physician takes the price of physician services, p, as given and chooses the number of patients to treat, n, and how much time to spend with each patient, t, to maximise

[2] The quality of this time is also important and depends on the expertise of the physician. The model can be extended so that physician expertise affects the quality of this time, but this overly complicates the analysis and adds no additional insights.

net payoff

$$U_P = p \cdot n - D(t \cdot n), \tag{2}$$

where $t \cdot n$ is the total time spent in treating n patients by a physician with quality of service, $q(t)$. $D(t \cdot n)$ is the monetary value of the dis-utility of this time and it is assumed to be an increasing strictly convex function. To participate, the physician needs payoff, $\overline{U}_P = 0$, the outside option.

2.3 The Policy-Maker

The policy-maker is risk neutral and maximises the expected net benefit of n patients being treated by a given physician, subject to the constraint that the physician participates. That is

$$\max \quad B(t) \cdot n - p \cdot n \quad s.t. \quad U_P \geq 0. \tag{3}$$

3 Social Optimum - First Best

The constraint in (3) binds and so the social optimum is found by solving,

$$\max_{t,n} \; W \equiv B(t) \cdot n - D(t \cdot n). \tag{4}$$

for t and n. Assuming a unique interior solution and that the second-order conditions for a maximum are satisfied, the solution for the social optimum can be achieved under decentralization, where the physician chooses t and n, if $p = B(t)$ and the physician receives a per-unit subsidy of $s = \frac{dB}{dt} \cdot n$ for time spent with patients.[3]

[3]It is assumed that the total number of patients treated at the social optimum is less than the number of patients seeking treatment. Treating all potential patients this period may too costly in terms of physician dis-utility of time. A cost could be included in (4) for leaving some patients untreated, but this would just add another term to welfare and would have no qualitative effects on the results in this paper concerning liability and time

This solution involves the physician extracting all the social surplus through price. This is needed to obtain the efficient activity level and is an artefact of the expected benefit of physician services being equivalent for all patients. The problem with this solution is that the policy-maker can not observe t. What the policy-maker can observe is the outcome or patient benefit from the services (or at least this can be determined by a court of law). So instead of using subsidies to reproduce the social optimum, other authors, Shavell (1980) and Arlen and MacLeod (2005), have demonstrated that making physicians liable for medical malpractice damage can achieve the same result.

It should be noted that at the social optimum there is a positive probability that medical malpractice occurs. That is, even if the physician spends the socially optimal amount of time with each patient, the physician can make an incorrect decision.

4 Physician Liability for Medical Malpractice

A tort occurs when one person's actions result in injury or harm to another person and this injury can be redressed through the law by awarding damages. Medical malpractice is a negligent tort. For a medical malpractice claim to be successful, the patient must prove that an injury occurred, that the physician caused the injury by action or in-action, and that the action or in-action represents a failure by the physician to exercise due care which is defined as the standard care of a reasonable medical practitioner, Danzon

spent on expertise and quality of service by physicians. An alternative would be to model entry and the number of physicians in the market so that all patients seeking treatment are treated. This avenue is not followed in order to keep the emphasis on the negligence rule.

(1991), Sloan (2008), and Weiler et al (1993). In a medical context, the two main goals of tort law are (i) to deter medical malpractice and (ii) to compensate patients for their injuries, Sloan (2008) and Weiler et al (1993).

4.1 A Model of Malpractice Claims under a Negligence Rule

It is assumed that patients can not observe whether a correct or incorrect diagnosis or treatment occurred. What they do observe is the outcome of treatment, b. How can they infer from b whether or not they have a claim for medical malpractice against a physician? Even if $b < E_M$, there can be some positive probability that the physician treated the patient correctly.

Assume patients have knowledge of the distributions of benefits under correct and incorrect treatments, $f(b|C$ and $f(b|M)$, as well as the historic proportions of correct and incorrect treatments, P_C and $P_M = 1 - P_C$. The patient is in a position to use Bayes Rule to determine the probability of medical malpractice given the outcome.

In fact, the probability of medical malpractice given outcome b is given by

$$P(M|b) = \frac{f(b|M)P_M}{f(b|M)P_M + f(b|C)P_C}. \tag{5}$$

$P(M|b)$ is an decreasing function of b. From the perspective of the patient, let the probability of winning a claim be $W(P(M|b))$. Given the balance of probabilities is used to determine guilt in civil cases it is assumed that[4]

$$W = 1 \quad for \quad P(M|b) \geq .5 \tag{6}$$

$$W = 0 \quad for \quad P(M|b) < .5 \tag{7}$$

[4]The standard of the balance of probabilities is met if the proposition is more likely to be true than not true. That is, the standard is met if there is a greater than .5 probability that the proposition is true

This particular form for $W(\cdot)$ is chosen because it greatly simplifies the exposition that follows.

Assume that it costs k to file a claim and that this cost is independent of actual damage. In addition, assume that the level of medical malpractice liability, L, is set by the policy-maker and is paid by the physician when the physician is found guilty of medical malpractice. It is also assumed that if a claim is made and the physician made an incorrect decision, then based on all evidence concerning the appropriateness of treatment, the courts determine malpractice occurred with probability one.[5]

A patient makes a claim if the expected payout, the probability of winning a claim multiplied by L, is greater than the cost of the claim, that is, if

$$W(P(M|b)) \cdot L > k. \tag{8}$$

Given $k > 0$, a claim is never made if $P(M|b) < .5$. Given $k > 0$ and $P(M|b) \geq .5$ a claim is made if $L > k$. For the remainder of this section it is assumed that $L > k$.

It is assumed that the probability distributions are such that there is a b_c, where for all $b < b_c$, $P(M|b_c) \geq .5$ and for all $b > b_c$, $P(M|b_c) < .5$. For interior solutions, b_c satisfies

$$\frac{f(b_c|M)P_M}{f(b_c|M)P_M + f(b_c|C)P_C} = .5, \quad or \quad \frac{f(b_c|M)}{f(b_c|C)} = \frac{P_C}{P_M} \tag{9}$$

[5]Studdert et. al. (2006) found that 73% of cases that involved an error involved compensation and 72% of claims that did not involve an error did not involve compensation. Peters (2006-7) surveyed many papers and concluded that settlement outcomes are driven by the strength of the plaintiff's case. Together, these papers provide evidence that the courts tend to make correct decisions or are expected to by the litigants. The case where there is court error in determining whether medical malpractice occurred in the presence of liability insurance is examined in Fagart and Fluet (2009). They find that decoupling damages from the victim's harm can improve efficiency.

As a result, the probability that a claim is made when medical malpractice has occurred is $F(b_c|M)$.

4.2 The Physician's and the Policymaker's Problems under Medical Malpractice Liability - Second Best

The probability a patient makes a claim is $F(b_c|M)$. From the perspective of the physician, the exante probability that medical malpractice occurs is $\big(1-\Pi(t)\big)$. Therefore from the perspective of the physician the probability that medical malpractice occurs and a claim is made is $\big(1-\Pi(t)\big)\cdot F(b_c|M)$. Given that if a claim is made and the physician made an incorrect decision, then the courts determine malpractice occurred with probability one, then $\big(1-\Pi(t)\big)\cdot F(b_c|M)$ is the probability that a physician has to pay L. Therefore, the expected liability payout of the physician per-patient is $EL = \big(1-\Pi(t)\big)\cdot F(b_c|M)\cdot L$.

The physician's problem is given by

$$\max_{t,n} U_P \equiv p \cdot n - D(t \cdot n) - EL \cdot n. \tag{10}$$

Assume a unique interior solution and that the second-order conditions for a maximum are satisfied.

In the presence of costly claims, if the policymaker could choose t and n to maximise expected welfare, then its problem is

$$\max_{t,n} W \equiv B(t) \cdot n - D(t \cdot n) - \big(1-\Pi(t)\big) \cdot F(b_c|M) \cdot k \cdot n, \tag{11}$$

where the last term in (11) is the expected cost of claims. Assume a unique interior solution and that the second-order conditions for a maximum are satisfied. Let the solution to this problem be t^* and n^*. This is a second-best optimum as claims are costly. In the decentralized solution, in which the policy-maker chooses L and p, if L and p are chosen so that

$$L = \frac{E_C - E_M}{F(b_c|M)} + k \quad and \quad p = B(t^*) + (E_C - E_M) \cdot \big(1 - \Pi(t^*)\big), \tag{12}$$

then the physician's problem is identical to the policymaker's problem and the physician chooses t^* and n^*. Let these second best optimal L and p be denoted by L^* and p^*.

For L^*, this result is similar to results found in Polinsky and Shavell (1998) and Arlen and MacLeod (2005), where damage and expected damage, respectively, are scaled-up by the reciprocal of the probability that the physician be found liable for damage when medical malpractice has occurred.[6] In addition, as in Shavell (1999), the physician is made liable for the cost of a claim. L^* makes physicians face the marginal social benefit of increasing t, namely, $\frac{d\Pi}{dt} \cdot (E_C - E_M + F(b_c|M)k)$. The physician now gets all the social surplus plus an additional amount to provide the correct incentives for the physician to choose n^*.[7] Discussion about the socially optimal activity level, n^*, is missing from the analysis of Arlen and Macleod (2005) as there is only one patient. It should be noted that as the cost of a claim k approaches zero, the second best optimum approaches the first best optimum and the optimal L approaches $\frac{E_C - E_M}{F(b_c|M)}$.

As discussed above, in a medical context, the two main goals of tort law are (i) to deter medical malpractice and (ii) to compensate patients for their injuries. Clearly, L^* yields the second best social optimum in terms of quality of service and the number of patients treated and so is an optimal

[6] Polinsky and Shavell (1998) refer to the difference between expected damages and these scaled-up damages as punitive damages.

[7] If instead of the physician only valuing income the physician also valued patient utility, it turns out that the optimal L and p are the same as in (12) above. Therefore, having more than two types of physicians does not alter the analysis unless the total number of patients is less than the total number of patients the physicians would like to service.

deterrent to medical malpractice. However, it fails to compensate patients for damage they actually suffer. A patient who has successfully claimed medical malpractice is paid $L^* = \frac{E_C - E_M}{F(b_c|M)} + k$ which is independent of the amount of damage actually incurred. This is true of Arlen and MacCleod (2005) and Shavell (1980) as well.

In practice, physicians are liable for the actual damage inflicted on patients. The object of compensatory damages is to make the patient as well off as if the correct decision was made, Sloan (2008 p.108), or what amounts to the same thing, to provide relief for the damages incurred, Cornell University Law School (2008). Polinsky and Shavell (1998) demonstrate that paying actual damage (or in some cases punitive damage based on actual damage) is socially optimal. However, in that paper damage is a fixed amount. In the framework of this paper, actual damage is not a fixed amount. Therefore, the effects of physicians being liable for actual damage need to be examined.

4.3 The Physician's Problem Under Liability for Actual Damage - Third Best

To begin, actual damage needs to be defined. This is complicated by the fact that the patient outcome might be poor even if the physician made a correct decision. In this paper, actual damage is defined as the difference between the benefit a patient expects to receive, given the physician made the correct decision, and the actual benefit the patient receives, given the physician made an incorrect decision. That is, the physician is liable for actual damage, $AD = E_C - b$, when the patient makes a successful medical malpractice claim.

Given b, a patient makes a claim if the expected payout is greater than the cost of a claim, that is, if

$$W(P(M|b)) \cdot (E_C - b) > k. \tag{13}$$

As above, if $P(M|b) < .5$, then a claim is never made. However, if $P(M|b) \geq .5$ a claim is made if $E_C - b > k$. That is, if $b \leq b_c$ and $b < E_C - k$. Therefore a claim is made if

$$b \leq min\ \{b_c, E_C - k\}. \tag{14}$$

Define b_k as the b for which (14) holds with equality. A claim is made for all $b \leq b_k$. The probability of a patient making a claim for actual damage is, therefore, $F(b_k|M)$. Note that for large k a claim is only made if b is small, that is, if actual damage is large.

From the point of view of the physician, expected actual damage is

$$EAD = \big(1 - \Pi(t)\big) \cdot \int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db. \tag{15}$$

This is the expectation of $E_C - b$ over all $b < b_k$, given medical malpractice has occurred, multiplied by the probability of medical malpractice occurring. Remember, a claim is made if $b < b_k$ and it is successful if M occurred. This happens with probability $\big(1 - \Pi(t)\big)$.

The physician's problem is given by

$$\max_{t,n} U_P \equiv p \cdot n - D(t \cdot n) - EAD \cdot n. \tag{16}$$

Assuming a unique interior solution, the first-order conditions for a maximum are

$$\frac{\partial U_P}{\partial t} = \big(\frac{d\Pi}{dt} \cdot \int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db - \frac{dD}{d(t \cdot n)}\big) \cdot n = 0, \tag{17}$$

and

$$\frac{\partial U_P}{\partial n} = p - \frac{dD}{d(t \cdot n)} \cdot t - \big(1 - \Pi(t)\big) \cdot \int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db = 0. \tag{18}$$

The second-order conditions for a maximum are assumed to be satisfied. Let the solution to these first-order conditions be given by $t(p)$ and $n(p)$.

Expected actual damage is an expected transfer from physicians to patients. If it is assumed that the policy-maker can use a lump-sum transfer to ensure that the physician's participation constraint binds, then the policy-maker's problem can be written as

$$\max_{p} \; W \equiv B\big(t(p)\big) \cdot n(p) - D\big(t(p) \cdot n(p)\big) - \big(1 - \Pi(t)\big) \cdot F(b_k|M) \cdot k \cdot n. \tag{19}$$

That is, the policy-maker maximises expected total surplus. Assuming a unique interior solution, this problem has first-order condition

$$\begin{aligned} \tfrac{dW}{dp} \quad &= \Big(\frac{d\Pi}{dt} \cdot (E_C - E_M + F(b_k|M) \cdot k) - \frac{dD}{d(t \cdot n)}\Big) \cdot n(p) \cdot \frac{dt}{dp} \\ + \quad &\Big(B\big(t(p)\big) - \frac{dD}{d(t \cdot n)} \cdot t - \big(1 - \Pi(t)\big) \cdot F(b_k|M) \cdot k\Big) \cdot \frac{dn}{dp} = 0. \end{aligned} \tag{20}$$

It is assumed that the second-order condition for a maximum is satisfied. This first-order condition is solved for $\hat{p}$ and in turn $\hat{t} = t(\hat{p})$, and $\hat{n} = n(\hat{p})$. This is a third best optimum as it involves costly claims and only one instrument, p.

Before a comparison of the solution under liability for actual damage is made with the second best optimum a number of results are derived.

Lemma 1: $\frac{dn}{dp} > 0$ and $\frac{dt}{dp} < 0$.

The proof of Lemma 1 is in the Appendix. The intuition for the increase in n in response to an increase in p is clear. An increase in price directly increases the marginal benefit of treating more patients and so more patients are treated. This increase in the number of patients treated, directly increases the marginal cost of total time spent with patients and so t is reduced.

Lemma 1 ensures that the locus $g(n, t) = (n(p), t(p))$ is negatively sloped. This locus is the set of points available to the policy-maker through its choice of p. Let the gradient vector of welfare, (19), be given by $\nabla W = (\frac{\partial W}{\partial n}, \frac{\partial W}{\partial t})$ and let the gradient vector of $g(n(p), t(p))$ be given by $\nabla g = (\frac{\partial n}{\partial p}, \frac{\partial t}{\partial p})$, then (20) can be written as

$$\nabla W \cdot \nabla g = 0 \tag{21}$$

That is, at the solution to problem (19), the slopes of the contours of $W(n, t)$ and $g(n, t)$ are equal.

Lemma 2: Assume price is fixed at the second best optimum, p^*. If $\int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db < E_C - E_M + F(b_k|M) \cdot k$, then $t(p^*) < t^*$ and $n(p^*) > n^*$.

The proof of Lemma 2 is in the Appendix. The intuition is clear. The condition that $\int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db < E_C - E_M + F(b_k|M) \cdot k$ ensures that expected actual damage is less than expected physician liability under the second best optimal L^*. As a result, having the physician liable for expected actual damage reduces the incentive the physician has to spend time with patients and also makes treating additional patients less costly relative to the second best optimal L^*. Therefore, $t(p^*) < t^*$ and $n(p^*) > n^*$.

Lemma 3: At t^*, the slope of the constraint, $g(n, t)$, is greater than the slope of the contours of welfare.

The proof of Lemma 3 is in the Appendix.

Proposition 1: *If* $\int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db < E_C - E_M + F(b_k|M) \cdot k$*, then* $\hat{t} < t^*$ *but the relationship between* $\hat{n}$ *and* n^* *is ambiguous.*

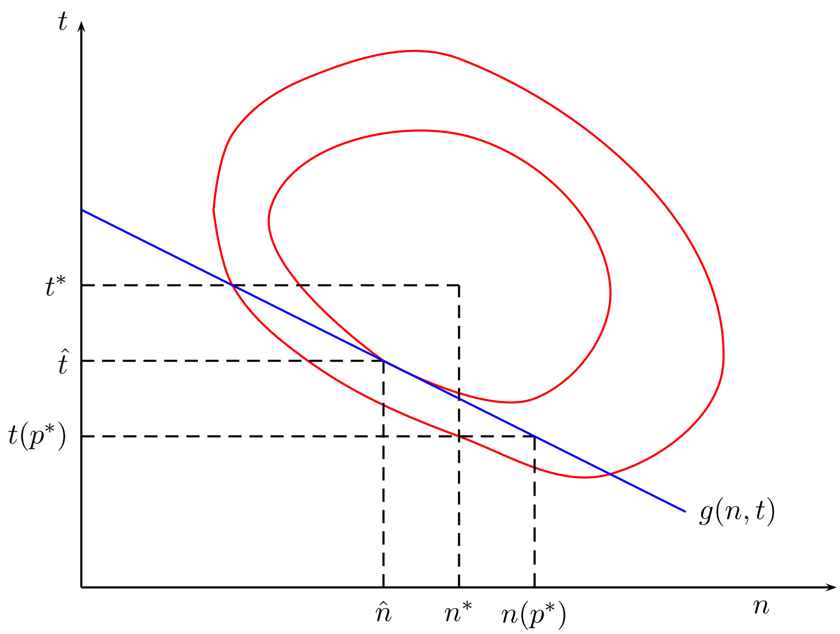
Proof: The constraint, $g(n(p), t(p))$, is negatively sloped by Lemma 1. By Lemma 2, if $p = p^*$, then the solution to the physicians problem is represented by a point where $t(p^*) < t^*$ and $n(p^*) > n^*$. By Lemma 3 and the convexity of the upper levels sets of welfare around the solution, $\hat{t} < t^*$ and the relationship between $\hat{n}$ and n^* is ambiguous.

The intuition is clear. If $\int_{\alpha_m}^{b_k}(E_C - b)f(b|M)db < E_C - E_M + F(b_k|M)\cdot k$, the expected payout of the physician under liability for actual damage is less than under L^*. Therefore at p^*, under liability for actual damage, the physician has less incentive to spend time with patients. The policy-maker can increase the physician's incentive to spend time with patients by decreasing price below p^*, but this is costly in terms of decreasing the number of patients treated. At $\hat{p}$ these two opposing effects on welfare are traded-off optimally.

The solution is shown in Figure 1.

Figure 1

Solution to Policy-Maker's Problem



Proposition 1 demonstrates that physicians spend too little time with patients relative to the second best optimum and so make too many incorrect decisions relative to the second best optimum. L^* provided the right incentives for time spent with patients, but did not compensate actual damage. Perhaps it is not surprising that compensating actual damage does not provide the right incentives for time spent with patients.

Proposition 1 was derived under the condition that $\int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db < E_C - E_M + F(b_k|M) \cdot k$, but under what conditions does this inequality hold? Weiler et.al. (1993) found that medical malpractice occurred once in every 100 patients. Therefore, it will be assumed that

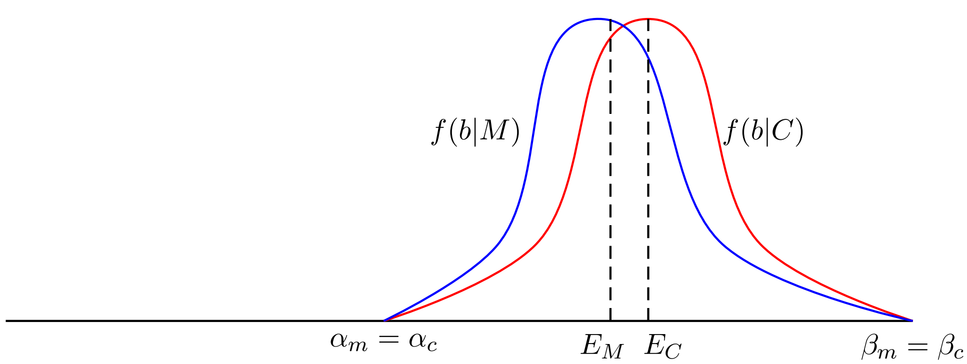
Assumption: $P_M << P_C$,

that is, the probability of an incorrect decision being made is substantially less than the probability of the correct decision being made.

First, consider $f(b|C)$ and $f(b|M)$ as drawn in Figure 2.

Figure 2

$f(b|C)$ and $f(b|M)$ have identical supports and are quite similar



These two distribution are quite similar and have the same support. Given the assumption above, the likelihood ratio $\frac{f(b|M)}{f(b|C)} < \frac{P_C}{P_M}$ for all outcomes b. Therefore $P(M|b) < .5$ for all b and the patient never makes a claim for medical malpractice. As a result, $\int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db = 0 < E_C - E_M < E_C - E_M + F(b_k|M) \cdot k$.

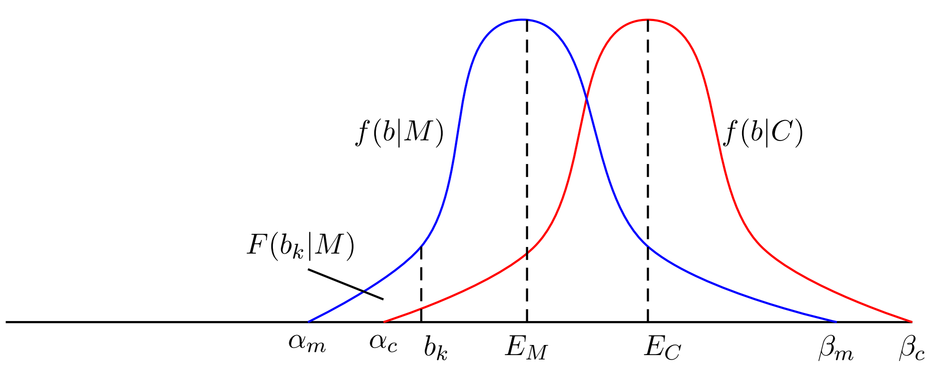
Second, consider Figure 3. The two distributions are quite similar but have different supports. In this case $b_k > 0$ exists, however, $F(b_k|M)$ is very small. Rearranging $\int_{\alpha_m}^{b_k}(E_C - b)f(b|M)db$ yields

$$\int_{\alpha_m}^{b_k}(E_C - b)f(b|M)db = F(b_k|M)\cdot(E_C - E[b \mid b < b_k, M]) \tag{22}$$

where $E[b \mid b < b_k, M]$ is the expected value of b, given $b < b_k$ and an incorrect decision is made. Although $(E_C - E[b \mid b < b_k, M]) > E_C - E_M$, because the expectation in $E[b \mid b < b_k, M]$ is only taken over relatively poor outcomes, $F(b_k|M)$ is very small. This ensures $\int_{\alpha_m}^{b_k}(E_C - b)f(b|M)db < E_C - E_M < E_C - E_M + F(b_k|M)\cdot k$.

Figure 3

$f(b|C)$ and $f(b|M)$ have different supports but are quite similar



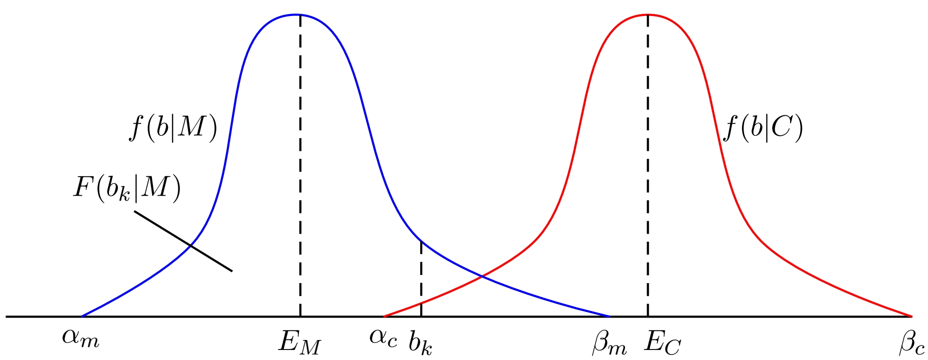
Third, consider Figure 4. The two distribution are quite different and have different supports. In this case $b_k > 0$ exists and $F(b_k|M)$ is quite large. Rearranging the condition that $\int_{\alpha_m}^{b_k}(E_C - b)f(b|M)db < E_C - E_M$ yields the equivalent condition

$$E_C > \frac{\int_{b_k}^{\beta_m} bf(b|M)db}{1 - F(b_k|M)} \qquad or \qquad E_C > E[b|\ b > b_k,\ M], \tag{23}$$

where $E[b|\ b > b_k,\ M]$ is the expected value of b given $b > b_k$ and an incorrect decision is made. As drawn, $b_k < \beta_m < E_C$. Therefore $E[b|\ b > b_k,\ M] < E_C$ and $\int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db < E_C - E_M < E_C - E_M + F(b_k|M) \cdot k$.

Figure 4

$f(b|C)$ and $f(b|M)$ have different supports and are quite different



Finally note that if $b_k = \beta_m$, then $\int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db = E_C - E_M < E_C - E_M + F(b_k|M) \cdot k$. The two supports of $f(b|M)$ and $f(b|C)$ are disjoint so that any outcome b in the support of $f(b|M)$ is evidence that medical malpractice has occurred with probability 1. Nevertheless, the second best optimum is not achieved and the physician spends too little time with patients compared to the second best optimum because the physician does not take into account the cost of claims.

In summary, for all possible distributions $f(b|M)$ and $f(b|C)$, $\int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db < E_C - E_M + F(b_k|M) \cdot k$ so too many incorrect decisions are made relative to the second best optimum.

Polinsky and Shavell (1998) showed that scaling up actual damage by the probability that a physician is found liable for damage attains the first best social optimum. In the set-up of this paper, if actual damage is scaled up by the probability that a claim is made, then the condition in Proposition 1 becomes $\int_{\alpha_m}^{b_k} \frac{(E_C - b)}{F(b_k|M)} f(b|M)db < E_C - E_M + F(b_k|M) \cdot k$. Now from (22) $\int_{\alpha_m}^{b_k} \frac{(E_C - b)}{F(b_k|M)} f(b|M)db = (E_C - E[b \mid b < b_k, M]) > E_C - E_M$ and the condition in Proposition 1 may not hold. If the physician is made liable for the cost of a claim so that the term $F(b_k|M) \cdot k$ disappears from the condition, then scaling up actual damage results in physicians spending too much time with patients relative to the second best optimum. The intuition is clear. Claims are only made when actual damage is relatively large $b \leq b_k$ and so scaling this amount up by the probability a claim is made when medical malpractice occurs results in physicians being exposed to too much liability relative to the second best optimum. As a result, they spend too much time with patients relative to the second best optimum in order to reduce this exposure.

4.4 The Model and the Data

The model developed above demonstrates that there is an optimal amount of time that physicians should spend with patients. Even if this optimal amount of time is spent, physicians can make an incorrect decision. With physicians liable for actual damage under a negligence rule Proposition 1 established that $\hat{t} < t^*$. As a result, the model predicts too many negligent medical injuries will occur relative to the second best social optimum. Weiler et.al. (1993) examined medical injuries in New York hospitals in 1984 and found that 1% of all patients suffered a negligent medical injury (p. 143). An earlier study, (Californian Medical Association 1977), used Californian hospital data from 1974 and found that 1 in 125 patients suffered a negligent medical injury. A later study, Wilson et.al. (1995), used Australian hospital data and found an even higher rate of medical malpractice with 1 in 12 hospital patients suffering a preventable adverse event.[8] Finally, Andrews (1997), using US hospital data, found that 17% of patients experienced serious adverse events. All of these studies were conducted in an environment in which physicians were liable for actual damage under a negligence rule.

Although, there is no way of determining the second best socially optimal level of medical malpractice from these empirical studies, it is clear that substantial medical malpractice occurred. This is in sharp contrasts with the prediction of Shavell (1980), where under a negligence rule all physicians undertake 'due care' and there is no medical malpractice or medical malpractice claims. However, it is consistent with the prediction of this paper that medical malpractice occurs even at the second best social optimum and at a level in excess of this optimum.

Another prediction of the model is that patients only make a claim for medical malpractice after observing a poor outcome, $b \leq min\ \{b_c, E_C - k\}$. Therefore, an incorrect decision can be made and yet no claim is made because the outcome is not poor enough. Weiler et.al. (1993) found that only 1 claim for negligence was lodged for every 7 negligent injuries, (p. 69), the Californian study, Californian Medical Association (1977), found that only one claim for negligence was lodged for every 10 negligent injuries, and Andrews (1997) found that only 1 claim for negligence was lodged for every 15 serious adverse events. These findings are consistent with outcomes in which $b > b_c$ and so a claim is not lodged even if malpractice occurred, or for outcomes in which b is large relative to $E_C - k$. The latter is consistent with the finding of Weiler et al, (p. 70-71) who found that nearly 80% of the patients who suffered a negligent injury, but did not lodge a tort claim,

[8] This Australian study used a more lax definition of an adverse event than the two US studies referred to above.

were either fully recovered from the injury within 6 months or were over 70 years of age and so their lost earnings were small ($E_C - b$ is small relative to k). It is also consistent with Danzon (1985) who found that the ratio of claims to injuries tended to be lower for minor relative to major injuries (once again where $E_C - b$ is small relative to k).

On the other hand, the model also predicts that a correct decision can be made and yet a claim is made because the outcome is poor. Weiler et al. found that most claims were ill-founded and that only 1 out of 2 tort claims were actually paid, (p. 139). Weiler et.al. also found that when tort claims were matched against independent appraisal of injury only 1 in 6 claims were found to involve medical negligence.[9]

5 Conclusion

This paper has examined the incentive effects of tort law under a negligence rule in the case where actual damage is compensated. It was shown that even in the case where the distributions of benefits, under correct and incorrect treatment, are such that patients assess the probability of malpractice as one, that compensating patients for actual damage does not lead to the second best optimum as litigation costs are not taken into account by physicians when making their decisions about how much time to spend with patients. As a result, too much malpractice occurs relative to the second best social optimum.

On the other hand, as litigation costs approach zero and so the second best approaches the first best social optimum, compensating actual damage only yields the second best (first best) social optimum in the case where the

[9] Presumably the courts had access to more information than the appraisers, so that 1 in 6 became 1 in 2.

distributions of benefits, under correct and incorrect treatment, are such that patients assesses the probability that malpractice has occurred as one. For all other distributions too little time is spent with patients and too much malpractice occurs relative to the second best social optimum.

Therefore, although compensating actual damage makes the patient as well off as if the correct decision was made it does not provide physicians with the appropriate incentive to spend the second best socially optimal amount of time with patients in the presence of litigation costs and/or where the probability a patient makes a claim when an incorrect decision is made is less than one.

6 Appendix

Lemma 1 - Proof: Totally differentiating first-order conditions (17) and (18) and applying Cramer's Rule yields

$$\frac{dn}{dp} = \frac{\frac{\partial^2 D}{\partial t^2} \cdot n - \frac{d^2 \Pi}{dt^2} \cdot \int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db}{\Delta} > 0, \tag{A-1}$$

where the numerator is greater than zero by one of the second-order conditions for a maximum and $\Delta > 0$ is the other second-order condition for a maximum, and

$$\frac{dt}{dp} = \frac{-\frac{\partial^2 D}{\partial t^2} \cdot t}{\Delta} < 0. \tag{A-2}$$

Lemma 2 - Proof: The physician's problem can be rewritten as

$$\max_{t,n} U_P \equiv p \cdot n - D(t \cdot n) - \big(1 - \Pi(t)\big) \cdot X \cdot n, \tag{A-3}$$

where X is the expected liability payout if a mistake is made. Totally differentiating the first order conditions for a maximum and applying Cramer's rule yields

$$\frac{\partial t}{\partial X} = sign \ \big[\frac{d\Pi}{dt} \cdot \frac{\partial^2 D}{\partial n^2} \cdot t^2 + \frac{\partial^2 D}{\partial n^2} \cdot t\big] > 0 \tag{A-4}$$

and

$$\frac{\partial n}{\partial X} = sign \ \big[(1 - \Pi) \cdot \Big(\frac{d^2 \Pi}{dt^2} \cdot X - \frac{\partial^2 D}{\partial t^2} \cdot n\Big) - \frac{d\Pi}{dt} \cdot \frac{\partial^2 D}{\partial t^2} \cdot n \cdot t\big] < 0. \tag{A-5}$$

The inequalities in (A-4) and (A-5) follow from $\Pi(t)$ being an increasing concave function and $D(t \cdot n)$ being an increasing convex function.

From (11) and (12), at the second best optimum $X = E_C - E_M + F(b_k|M) \cdot k$. Under liability for actual damage $X = \int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db$. As $E_C - E_M + F(b_k|M) \cdot k > \int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db$, $t(p^*) < t^*$ and $n(p^*) > n^*$.

Lemma 3 - Proof: From (A-1) and (A-2) the slope of the constraint, $g(n(p), t(p))$ is

$$\frac{\frac{dt}{dp}}{\frac{dn}{dp}} = \frac{-\frac{\partial^2 D}{\partial t^2} \cdot t}{\frac{\partial^2 D}{\partial t^2} \cdot n - \frac{d^2 \Pi}{dt^2} \cdot \int_{\alpha_m}^{b_k} (E_C - b) f(b|M) db} < 0 \tag{A-6}$$

Applying the implicit function theorem to (11) gives the slope of the contours of W, namely,

$$\frac{dt}{dn} = -\frac{\frac{\partial W}{\partial n}}{\frac{\partial W}{\partial t}} = -\Big(\frac{B(t) - D'(\cdot) \cdot t - (1 - \Pi(t)) \cdot F(\cdot) \cdot k}{B'(t) \cdot n - D'(\cdot) \cdot n + \Pi'(t) \cdot F(\cdot) \cdot k \cdot n}\Big) \tag{A-7}$$

Rearranging the first order conditions of problem (11) yields

$$\frac{B(t) - (1 - \Pi(t) \cdot F(\cdot) \cdot k}{t} = B'(t) + \Pi'(t) \cdot F(\cdot) \cdot k, \tag{A-8}$$

which is solved for t^*. Substituting (A-8) into (A-7) yields the slope of the the contours of W at t^*, namely,

$$\frac{dt}{dn} = -\frac{t^*}{n} \tag{A-9}$$

By inspection, at t^*, the slope of the constraint is greater than the slope of the contours for all n.

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