Physician Mobility and the Differential Effects of Defensive Medicine

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The empirical literature on defensive medicine includes studies utilizing data at the state or county level. In comparison to the rest of the literature, these jurisdictional studies typically find the least evidence that rising malpractice liability costs induce cost-increasing or quality-reducing practices by physicians. A key assumption in these studies is that changes in malpractice pressure have no cross-jurisdictional effects on health care spending and quality. If physicians are mobile and malpractice pressure influences their location decisions, these studies neglect an important channel for such cross-jurisdictional effects. This paper constructs a theoretical model in which multiple insurers compete to provide consumers with health insurance while facing mobile physicians. Analytical and numerical results show that, through this mobility channel, changes in malpractice pressure unique to one jurisdiction influence health care spending and quality in other jurisdictions. This physician location decision can also be interpreted as one of allocating time over different types of patients or procedures, allowing the model to investigate how defensive medicine differentially affects distinct, contemporaneous patient populations.

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1. Introduction

Defensive medicine refers to the treatment decisions made by physicians primarily to avoid medical malpractice liability rather than benefit patients. Examples include the ordering of unnecessary and costly diagnostic procedures to assure against any claims of negligence, or the avoidance of patients or procedures though to be particularly at risk of resulting in a malpractice claim. Numerous surveys of physicians and the advocacy efforts of the American Medical Association report that defensive medicine is both widely practiced and a primary reason for the rising cost of consumer health insurance and/or restricted access to care (Bovbjerg et al 1996, Studdert at al 2005, Dove et al 2010, Lumalcuri & Hale 2010, Reyes 2010, Sethi et al 2012). This has created advocacy for legislated malpractice reforms, mostly at the state-level. Researchers, too, have paid attention to the subject of defensive medicine. These empirical studies most often involve investigations into a possible relationship between various measures of medical malpractice liability costs, or “malpractice pressure”, and health care spending and/or quality. The results of these
studies have been mixed, and have led some researchers to conclude that defensive medicine has not played a policy-relevant role in rising US health care expenditure, and that malpractice reform is thus unwarranted (Helland & Showalter 2009, Lakdawalla & Seabury 2009, Sloan & Shadle 2009, Avraham & Shanzenbach 2010, Reyes 2010, Cotet 2012).

A significant share of the empirical investigations into defensive medicine utilize data based on geographic jurisdictions, usually at the state or county level (Baicker & Chandra 2005, Baicker et al 2007, Hellinger & Encinosa 2006, Lakdawalla & Seabury 2009, Paik et al 2011). The goal is to determine whether health care spending or quality is systematically different in jurisdictions with high malpractice pressure. The empirical models used in these studies, however, assume that the malpractice pressure in a given state affects health care spending only within that state. This specification neglects any potential effects that malpractice pressure in one state may have on the cost or quality of health care in other states.

One channel through which these cross-jurisdictional effects might occur is physician mobility. Both practicing physicians and newly graduated physicians have some discretion over which geographic region in which to locate their practices. Given the survey results, it appears that malpractice insurance premiums and the prospect of a malpractice lawsuit are a source of concern for physicians. For this reason, if all other considerations were equal, physicians would prefer to locate in jurisdictions where they would face low malpractice pressure. It then follows that rising malpractice pressure in one jurisdiction could trigger physician relocation, and thus affect the cost or quality of health care in other jurisdictions.

The potential reactions of health insurers to physician mobility makes the ultimate effect on health care spending and quality ambiguous. The number of physicians available to treat an insurer’s policyholders represent an input into the quality of the health insurance they provide. If these physicians were to begin departing due to an increase in malpractice pressure, one possible response from insurers is to raise physicians’ compensation to offset the increased malpractice liability costs and induce them to remain. An insurer could take this action a step further by raising compensation enough to attract physicians from other jurisdictions in order to spread the
malpractice risk of treating the insurer’s policyholders. This would leave insurers in other jurisdictions facing outflows of physicians, and could induce them to take like action. In this way, rising malpractice pressure in one jurisdiction could cause increases in health care spending in multiple jurisdictions. On the other hand, if the initial insurer chose not to raise physician compensation, the outflow could create more competition among physicians in other jurisdictions and thus lower the cost of care. For these reasons, it is not obvious how mobile physicians’ reactions to changes in malpractice pressure would affect health care spending and quality across other jurisdictions in equilibrium.

Failing to account for cross-jurisdictional effects would bias the estimated effects of changes in malpractice pressure. For example, if rising malpractice pressure in jurisdiction $i$ caused increases in health care spending in jurisdiction $k$ as well as $i$, the estimated effect on jurisdiction $i$ would be biased toward zero. Alternatively, if the effect on jurisdiction $k$ were negative, the estimated effect would be positive and inflated. One goal of this paper is to investigate whether physician mobility creates cross-jurisdictional effects from rising malpractice pressure, and what kind of bias this would create in an empirical study that didn’t account for physician mobility. This is done using a theoretical model of the interactions between consumers, physicians, and health insurers. These decision makers reside in one of two jurisdictions. It is assumed that consumers are immobile, and must therefore make all of their decisions within their jurisdiction of origin. Through an assumption on the competitiveness of the health insurance market described below, health insurers are also rendered effectively immobile. Physicians, on the other hand, are able to locate in either jurisdiction. In equilibrium, therefore, physicians would only occupy a jurisdiction in which they have a weak preference to practice.

The most literal interpretation of these jurisdictions is a geographical one. There is also a more abstract interpretation; that they represent mutually exclusive specialties, subspecialties, or other "options" that a physician could pursue. For example, a location decision for obstetrician/gynaecologists would consist of whether to focus exclusively on obstetrics or gynaecology, or the share of their practice to devote to one or the other. This allows the model to serve a second
function: determining whether and how changes in a common level of malpractice pressure would differentially affect two distinct populations of consumers. This exercise sheds some light on the equity considerations of rising malpractice pressure.

To determine the qualitative effects on health care spending and quality, the model is solved numerically for various cases of rising malpractice pressure. Results indicate that physician mobility inflates estimates of the effect of malpractice pressure on measures of health care system quality. On the other hand, the effects on health care spending can be biased either toward or away from zero, depending on other jurisdictions’ approach to competition for physicians. Finally, in investigating the differential effects of defensive medicine, the model predicts that physicians would exit poorer jurisdictions for more wealthy ones. This matches some existing empirical findings, which showed that physicians tend to depart rural areas for urban areas as malpractice pressure rises (General Accounting Office 2003).

2. The Model

The model environment is made up of two jurisdictions. Each jurisdiction \( i \in \{1, 2\} \) contains a population of identical consumers of measure 1, although consumers need not be identical across jurisdictions. Each consumer is endowed with income \( m_i \) and is immobile, and thus confined to his jurisdiction of origin. Similar to Montanera (2012), a consumer’s preferences are represented by the utility function \( U_i(y, H) \), where \( y \) is consumption and \( H \) is the consumer’s health status.

The utility function is continuous, differentiable, and strictly concave. In the absence of health insurance, the health status of a consumer in jurisdiction \( i \) is a binary random variable, taking the value \( H_{i1} \) (healthy) with probability \( q_i \) and \( H_{i2} \) (ill) with probability \( 1 - q_i \). Before the value of a consumer’s health status is revealed, he can purchase a health insurance policy at a price of \( \tau_i \). Health insurance allows consumers who become ill to recover their healthy status with probability \( Q_i \), which is labelled the “quality” of the health insurance available to consumers in jurisdiction \( i \).

Therefore, the expected utility of a consumer in jurisdiction \( i \) is:
\[ EU_i = (1 - q_i + q_i Q_i) U_i(m_i - \tau_i, H_{i1}) + (q_i - q_i Q_i) U_i(m_i - \tau_i, H_{i2}) \]

There is a continuum of physicians of measure D. Each physician is endowed with s rivalrous units of resources for use in the treatment of ill consumers, otherwise known as patients. Examples of these kinds of resources include the physician’s time and attention. By expending resources \( t \) in the treatment of a given patient, a physician increases the probability that the patient recovers from 0 to \( 1 - \rho_i(t) \). The function \( \rho_i(t) \) can be considered the probability of an adverse outcome, where the patient remains in the poor health status despite receiving treatment. It is assumed to be positive, decreasing in \( t \), and strictly convex, where \( \rho_i(0) = 1 \) and \( \lim_{t \to \infty} \rho_i(t) = 0 \). These assumptions are designed to impose diminishing returns of physicians’ endowed resources on the treatment of patients.

Each adverse outcome in jurisdiction \( i \) brings an uninsurable expected malpractice liability cost of \( P_i \) upon the treating physician. This parameter, which serves as a measure of “malpractice pressure” in the model, is a composite of several factors contributing to malpractice liability costs. These include the likelihood that adverse outcome leads to a lawsuit, the reputational and psychic costs of participating in a trial, the prospect of malpractice awards exceeding the limits of malpractice insurance, etc. This means that the expected liability cost from treating a patient in jurisdiction \( i \) with \( t \) units of resources is \( \rho_i(t) \cdot P_i \).

Each physician must choose which jurisdiction in which to locate her medical practice \( (c_j \in \{1, 2\}) \), and given such choice, must also choose the number of cases to take on \((n_i)\). Each patient actually treated in jurisdiction \( i \) brings in a payment of \( w_i \). Also, since all consumers in a given jurisdiction are identical and \( \rho_i(.) \) is convex and decreasing, then for any choice \( n_i \), total liability costs will be minimized where each patient receives an equal amount of resources in their treatment. Therefore, given the choice to locate in jurisdiction \( i \), each physician’s profit-maximizing caseload size \( (n_i^*) \) would solve:
In making a location decision, physicians’ payoffs are made up of two components. The first is the net returns from practicing medicine in jurisdiction $i$, labelled $\pi_i$. Let $D_1$ and $D_2$ be the measures of physicians practicing in jurisdictions 1 and 2 respectively. Since the total measure of ill consumers in jurisdiction $i$ is $q_i$, the maximum number of patients that each physician could actually treat is $\frac{q_i}{D_i}$. Let $\tilde{n}_i = \min \left\{ n_i, \frac{q_i}{D_i} \right\}$ be the actual number of patients the physician treats. Therefore, net returns are total revenues ($w_i \tilde{n}_i$) minus total expected malpractice liability costs $\tilde{n}_i \rho_i(.) P_i$. The second component is an idiosyncratic locational preference of physician $j$ for practicing in jurisdiction $i$ ($\epsilon_{ij}$). Let $\epsilon_{1j} = 0$ for all $j$ and $\epsilon_{2j}$ be distributed according to the cumulative distribution function $F(\epsilon_2)$ over the support $(-\infty, \infty)$. This means that $\epsilon_{2j}$ is physician $j$’s relative preference for practicing in jurisdiction 2 instead of jurisdiction 1. Let $dF(.)$ be symmetric around the origin to abstract away from any systematic preference for one jurisdiction over another. Therefore, physician $j$’s location choice $c^*_j$ is jurisdiction $i$ if and only if:

$$\pi_i + \epsilon_{ij} \geq \pi_k + \epsilon_{kj} \quad i, k \in \{1, 2\}, \quad i \neq k$$

where

$$\pi_i = \pi_i(w_i, P_i) = \max_{n_i \geq 0} \left\{ w_i \tilde{n}_i - \tilde{n}_i \cdot \rho_i \left( \frac{s}{\tilde{n}_i} \right) P_i \right\}$$

Since $\pi_i(w_i, P_i)$ is a function of $\tilde{n}_i$ instead of $n^*_i$, location decisions are based on the actual number of patients each physician would treat in jurisdiction $i$ rather than that which the physician would like to treat. Since $n^*_i$ is unaffected by $D_i$, while $\tilde{n}_i$ may be affected by $D_i$, the net returns from practicing that each physician $j$ uses to make her location decision must be consistent with the location decisions of every other physician ($\epsilon_{i \neq j}$).
Assume that the market for health insurance is perfectly competitive in each jurisdiction. This means that, in equilibrium, the insurance policies offered to consumers in jurisdiction $i$ must be that which maximizes expected consumer utility subject to a zero-profit constraint. All results are identical whether there is a single insurer in each jurisdiction, or alternatively, a single insurer across jurisdictions facing potential jurisdiction-based entrants. All insurers operating in this environment are managed care organizations (MCO), and as such, sign contracts with both consumers (for $Q_i$ and $\tau_i$) as well as a contract with physicians. As a simplification of Montanera (2012), the contract between an MCO in jurisdiction $i$ and a physician consists of a payment ($w_i$) for each policyholder the physician treats. It is assumed that MCOs and physicians cannot contract directly on $n_i$. In the real world, this type of contract would be extremely costly to enforce due to the vast heterogeneity across patients and illnesses and the difficulty in verifying illness and proper treatment for the purposes of a contract. Instead, contracts require physicians to exercise judgement in determining whether and what kind of treatment is provided. Even though this model abstracts away from heterogeneity across patients within a given jurisdiction, it assumes the contracting problem to exist without explicitly modelling it. Therefore, the number of patients treated enters each MCO’s problem as an incentive compatibility constraint rather than a choice variable.

Given the structure of the contracts, the competition in the health insurance market, and the need for incentive compatibility, the $\{Q_i, \tau_i\}$ offered by an MCO to consumers depends on the choice of $w_i$, and the resulting behaviour of physicians. A patient’s recovery in this model is the result of two events. First, the patient must gain access to a physician in order to receive medical services. If the patients are allocated randomly across physicians in a given jurisdiction, then the probability that any of the $q_i$ patients finds a place among the $n_i$ cases that each of $D_i$ physicians are willing to take on is $\frac{D_i n_i}{q_i}$. Second, conditional on gaining access to a physician and receiving treatment, the probability that the treatment is successful and leads to recovery is $1 - \rho_i(\cdot)$. Thus, the probability of recovery ($Q_i$) is the product of these two probabilities:

$$Q_i \left( n_i, \frac{s}{n_i} \right) = \left( \frac{D_i n_i}{q_i} \right) \left( 1 - \rho_i \left( \frac{s}{n_i} \right) \right)$$
Due to perfect competition, the MCO in jurisdiction $i$ must set the revenues from the sale of health insurance policies to each of the measure 1 of consumers ($\tau_i$) equal to the costs of treating patients. With $D_i$ physicians each treating $\tilde{n}_i$ patients at a cost to the insurer of $w_i$ per patient, these total costs equal $D_i\tilde{n}_iw_i$. Therefore, the MCO in jurisdiction $i$ solves the problem:

$$\max_{w_i} \left\{ (1-q_i)U_i(m_i - \tau_i, H_{i1}) + q_iU_i(m_i - \tau_i, H_{i2}) + q_i\tilde{Q}_i \cdot \Delta U_i \right\}$$

where $\tau_i = D_i\tilde{n}_iw_i$

$$\tilde{Q}_i = Q_i\left(\frac{s}{\tilde{n}_i}\right) = \left(\frac{D_i\tilde{n}_i}{q_i}\right) \left(1 - \rho_i \left(\frac{s}{\tilde{n}_i}\right)\right)$$

$$\Delta U_i = U_i(m_i - \tau_i, H_{i1}) - U_i(m_i - \tau_i, H_{i2})$$

Given $\{s, D, \{q_i, m_i, H_{i1}, H_{i2}, P_i\}_{i=1,2}\}$, equilibrium is each physician $j$’s location choice $c_j^*$, a physician’s choice of caseload size in jurisdiction $i$, $\{n_i^*(w_i, s, P_i)\}_{i=1,2}$, and each MCO’s choice of a payment per patient, $\{w_i^*\}_{i=1,2}$ such that:

1) given $c_{i\neq j}$, $c_j^* = \begin{cases} 1 & \text{if } \pi_1 \geq \pi_2 + \epsilon_2j; \\ 2 & \text{otherwise.} \end{cases}$

2) $n_i^*(w_i, s, P_i) = \arg\max_{n_i \geq 0} \left\{ w_in_i - n_i \cdot \rho_i \left(\frac{s}{n_i}\right) P_i \right\}$

3) $w_i^* = \arg\max_{w_i \geq 0} \left\{ EU_i \middle| \tau_i = D_i\tilde{n}_iw_i \right\}$
3. Equilibrium: Analytical

The condition characterizing a physician’s optimal caseload size $n_i^*(w_i, s, P_i)$ is the same as in Montanera (2012). A physician practicing in jurisdiction $i$, and thus facing $w_i$ and $P_i$, would like to set $n_i$ such that:

$$\frac{w_i}{P_i} = \rho\left(\frac{s}{n_i}\right) - \left(\frac{s}{n_i}\right) \cdot \rho'\left(\frac{s}{n_i}\right)$$

where $\rho'(.)$ is the first derivative of $\rho(.)$. A unique finite solution exists for all $w_i \in [0, P_i)$. Changes in $w_i$ and $P_i$ produce the opposite effects on $n_i^*$. An increase in $w_i$ increases the profitability of the marginal patient and induces physicians to increase their caseloads, thus both increasing total revenues as well as taking on greater liability exposure. An increase in $P_i$ makes the marginal patient too risky to treat, causing physicians to reduce liability exposure by taking on fewer patients.

Physicians’ location decision depends on the actual number of patients they would treat in each jurisdiction $\tilde{n}_i$ rather than the number they would like to treat. This is important in determining whether or not $n_i^*$ is a best response of a physician locating in jurisdiction $i$. If $n_i^* < \frac{D_1}{P_i}$, then $n_i^*$ is the only element of the argmax in the physician’s problem. The case of $n_i^* \geq \frac{D_1}{P_i}$ is slightly more complicated since $\tilde{n}_i$ is unchanging as $n_i^*$ increases. In this case, therefore, the argmax consists of the set $\left[\frac{D_1}{P_i}, \infty\right)$. However, since $n_i^* \in \left[\frac{D_1}{P_i}, \infty\right)$ in this case, it is therefore always a best response for every physician practicing in jurisdiction $i$ to choose the caseload size $n_i^*$.

Physician $j$ must compare the net returns from practicing in the two jurisdictions. Since there is a continuum of physicians, the measure of physician $j$ is infinitesimal. Therefore, the location decisions of every other physician $(c_{i \neq j})$ result in $D_1$ and $D_2$ physicians practicing in jurisdictions 1 and 2 respectively. Given $(c_{i \neq j})$, and thus $D_1$ and $D_2$, it is optimal for physician $j$ to locate in jurisdiction 1 if $\epsilon_{2j} \leq \pi_1 - \pi_2$, and in jurisdiction 2 otherwise. Given the distributional assumptions on $\epsilon_{2j}$, and that this decision rule must hold for all $j$, it must be true in equilibrium that $D_1 = D \cdot F(\pi_1 - \pi_2)$ and $D_2 = D \cdot (1 - F(\pi_1 - \pi_2))$. 
The first-order condition from MCO $i$’s problem is:

$$q_i \Delta U_i \frac{\partial \tilde{Q}_i}{\partial w_i} = WMU_{yi} \frac{\partial \tau_i}{\partial w_i}$$

(3)

where $WMU_{yi}$ is the “weighted marginal utility of consumption” in jurisdiction $i$, and can be considered the expected marginal utility of consumption for a consumer after purchasing health insurance.

The left side of (3) is the marginal benefit of increasing physician payments in jurisdiction $i$ ($MB_i$). It is the increased likelihood $\frac{\partial \tilde{Q}_i}{\partial w_i}$ that the ill consumers in jurisdiction $i$ (with measure $q_i$) will receive the increase in utility that arises due to recovery ($\Delta U_i$). The right side is the marginal cost ($MC_i$). It is the value of the consumption forgone as the price of insurance increases to fund the increased physician payments.

If the Inada conditions hold, then $w^*_i \in \left[0, \frac{m_i}{q_i}\right]$. As $w_i$ approaches the upper bound of this range, consumption would be driven to zero, causing $WMU_{yi}$ to approach infinity and the first-order condition to be violated. The MCOs’ problems are complicated because neither $\frac{\partial \tilde{Q}_i}{\partial w_i}$ nor $\frac{\partial \tau_i}{\partial w_i}$ is necessarily continuous in $w_i$. The principal effects of increasing $w_i$ are first, an increase in physicians practicing in jurisdiction $i$ ($\frac{\partial n^*_i}{\partial w_i} \geq 0$ since $\frac{\partial \pi_i}{\partial w_i} \geq 0$) and second, each physician desiring a greater caseload ($\frac{\partial n^*_i}{\partial w_i} \geq 0$). As long as $n^*_i < \frac{q_i D_i}{\tilde{Q}_i}$, the product $D_i \tilde{n}_i$ increases in $w_i$. Once $n^*_i \geq \frac{q_i D_i}{\tilde{Q}_i}$, the product equals $q_i$; a constant. This is because, even though the higher payments induce more physicians to locate in jurisdiction $i$, the scarcity of ill consumers results in each of those physicians actually treating fewer patients, even though they would like to treat more. This results in a discontinuous negative shift in both $\frac{\partial \tilde{Q}_i}{\partial w_i}$ and $\frac{\partial \tau_i}{\partial w_i}$ once $w_i$ is such that $n^*_i = \frac{q_i D_i}{\tilde{Q}_i}$. This value of $w_i$ is labelled “$\tilde{w}_i$” in Figures 1 to 3. The discontinuities mean that an equilibrium could exist where the first-order conditions do not hold. That is, it could be optimal for an MCO to set $w_i = \tilde{w}_i$. A jurisdiction $i$ in this kind of equilibrium would be characterized by a condition other than its first-order condition, namely $n^*_i = \frac{q_i D_i}{\tilde{Q}_i}$.
Altogether, there are three types of solution for each MCO’s problem: limited-access \( n_i^* < \frac{q_i}{D_i} \), full-access-corner \( n_i^* = \frac{q_i}{D_i} \), and full-access-interior \( n_i^* > \frac{q_i}{D_i} \). These different types of solution
are shown in Figures 1 to 3. Since there are two MCOs modelled here, the possible combinations of the three potential solution types result in six potential equilibrium types. Even though there is the potential for a no-insurance equilibrium ($w^*_i = 0$), this case will not be investigated here since it is easily distinguished from the other potential equilibrium types. Each set of these equilibrium choices \( \{w^*_i\}_{i=1,2} \) is characterized by a pair of conditions for \( i = 1, 2 \):

\[
\begin{align*}
\text{if } n^*_i(w^*_i, s, P_i) &\neq \frac{q_i}{D_i}, & q_i \Delta U_i \frac{\partial Q_i}{\partial w_i} &= W M U_i \frac{\partial \tau_i}{\partial w_i} \\
\text{else } n^*_i(w^*_i, s, P_i) &= \frac{q_i}{D_i}
\end{align*}
\]

4. Equilibrium: Numerical

In order to investigate these equilibria numerically, assume the following functional forms:

\[
\begin{align*}
\rho_i(t) &= \frac{1}{1 + \alpha_i t}, & U_i(y_i, H_i) &= H_i^{\beta_i} y_i^{1-\beta_i}, & \epsilon_{2j} &\sim N(0, \sigma^2)
\end{align*}
\]

where \( \alpha_i > 0, 0 < \beta_i < 1, \) and \( \sigma^2 > 0 \). Besides complying with the conditions posed earlier, the choice of functional form for \( \rho_i(.) \) is convenient as it yields a closed form solution for \( n^*_i \), which is non-negative and finite for all \( w_i \in [0, P) \):

\[
n^*_i = \alpha_i s \left[ \left( \frac{P_i}{P_i - w_i} \right)^{\frac{1}{2}} - 1 \right]
\]

The MCO’s problem is complicated by the relationships between \( w_i, \pi_i, \) and \( D_i \). Given a choice of \( w_1 \) and \( w_2; \pi_1, \pi_2, D_1, \) and \( D_2 \) would be determined simultaneously by the system of equations:

\[
\pi_1 = w_1 \tilde{n}_1 - \tilde{n}_1 \rho_1 \left( \frac{s}{\tilde{n}_1} \right) P_1
\]
\[
\pi_2 = w_2 \tilde{n}_2 - \tilde{n}_2 \rho_2 \left( \frac{s}{\tilde{n}_2} \right) P_2 \\
D_1 = D \cdot F(\pi_1 - \pi_2) \\
D_2 = D \cdot (1 - F(\pi_1 - \pi_2))
\]

Since \( \tilde{n}_i \) is case-specific, and these cases depend on \( D_i \), this system is computationally difficult to work with. Alternatively, since \( D_i \) is monotonically increasing in \( \pi_i \), and \( \pi_i \) is monotonically increasing in \( w_i \), any pair \( \{\pi_1, \pi_2\} \) produces the unique pairs \( \{D_1(\pi_1, \pi_2), D_2(\pi_1, \pi_2)\} \) and \( \{w_1(\pi_1, \pi_2), w_2(\pi_1, \pi_2)\} \) such that:

\[
D_1(\pi_1, \pi_2) = D \cdot F(\pi_1 - \pi_2) \\
D_2(\pi_1, \pi_2) = D \cdot (1 - F(\pi_1 - \pi_2)) \\
w_1(\pi_1, \pi_2) = \begin{cases} 
\frac{w_1}{\frac{D_1(\pi_1, \pi_2)}{q_1}} \pi_1 + \rho_1 \left( \frac{D_1(\pi_1, \pi_2)}{q_1} \right) P_1 & \text{if } n_1^*(w, s, P_1) < \frac{q_1}{D_1(\pi_1, \pi_2)}; \\
\frac{w_2}{\frac{D_2(\pi_1, \pi_2)}{q_2}} \pi_2 + \rho_2 \left( \frac{D_2(\pi_1, \pi_2)}{q_2} \right) P_2 & \text{otherwise.}
\end{cases}
\\nw_2(\pi_1, \pi_2) = \begin{cases} 
\frac{w_2}{\frac{D_2(\pi_1, \pi_2)}{q_2}} \pi_2 + \rho_2 \left( \frac{D_2(\pi_1, \pi_2)}{q_2} \right) P_2 & \text{if } n_2^*(w, s, P_2) < \frac{q_2}{D_2(\pi_1, \pi_2)}; \\
\frac{w_1}{\frac{D_1(\pi_1, \pi_2)}{q_1}} \pi_1 + \rho_1 \left( \frac{D_1(\pi_1, \pi_2)}{q_1} \right) P_1 & \text{otherwise.}
\end{cases}
\]

without having to simultaneously solve a system of equations. Therefore, instead of choosing \( w_i \), each MCO will do the equivalent of choosing \( \pi_i \) to solve its problem given the other MCO’s choice of \( \pi_k \).

The program solves MCO \( i \)'s problem given a parameterized value of the other MCO’s net return from practicing (\( \bar{\pi}_{i0} \)). It then compares the solution to that problem \( \pi_i^*(\bar{\pi}_{i0}) \) with the initial parameterized value used in the other MCO’s problem (\( \bar{\pi}_{i0} \)). If \( |\pi_i^*(\bar{\pi}_{i0}) - \bar{\pi}_{i0}| \) for either MCO is greater than some tolerance parameter, the program replaces both \( \bar{\pi}_{i0} \) with \( \pi_i^* = \pi_i^*(\bar{\pi}_{i0}) \) and then resolves the two MCO’s problems until the solutions converge to the updated parameterized values.
5. Results

The purpose of the numerical simulations is to examine the effects of rising malpractice pressure on variables of interest in the two jurisdictions. This is done in three parts. Part 1 examines the effect of rising malpractice pressure in jurisdiction 1 while the malpractice pressure in jurisdiction 2 is held constant at a level such that MCO 2 offers full access to its policyholders. Other than the difference in malpractice pressure, the two jurisdictions are identical in every parameter. Part 2 does the same, with the exception that malpractice pressure in jurisdiction 2 is held constant and is high enough to induce MCO 2 to provide only limited access. These exercises allow for investigation into possible systematic biases in the coefficients uncovered by studies using data at the jurisdiction-level (state or county) without accounting for physician mobility. Part 3 has a different purpose from parts 1 and 2. It is designed to investigate the effects on two distinct populations of increases in a common level of malpractice pressure \( P_1 = P_2 = P \) when physicians can decide whether and how much to focus on each population. In this context, a population is equivalent to a jurisdiction. While the malpractice pressure from treating the two jurisdictions is identical for the purposes of part 3, consumers in jurisdiction 1 are assumed to have greater income than those in jurisdiction 2.

As parameter values in all three parts, assume that the measure of the entire set of physicians \( (D) \) is 0.2 and that each physician possesses resources \( (s) \) equal to 50. The variance on physicians’ relative locational preference \( (\sigma^2) \) is 50. The technology parameter of converting resources into successful outcomes from treatment \( (\alpha_i) \) is set at 2. The probability of becoming ill in either jurisdiction \( (q_i) \) is 0.5, and health statuses \( H_{i1} \) and \( H_{i2} \) are 1 and 0.5 respectively. For parts 1 and 2, consumer income in either jurisdiction \( (m_i) \) is set at 100. In part 3, while \( m_1 \) remains at 100, \( m_2 \) is reduced to 90. As a tolerance parameter used in the numerical optimization, equilibrium \( \{\pi_1^*,\pi_2^*\} \) is considered found on the \( z^{th} \) iteration if and only if \( |\pi^*_i(\bar{\pi}_kz) - \bar{\pi}_{iz}| \leq 0.1 \) for both jurisdictions. Let the equilibrium values for the number of doctors emerging in jurisdiction \( i \) in equilibrium be \( D_i^* = D_i(\pi_1^*,\pi_2^*) \), each physician’s caseload size be \( n_i^* = min\{n_i^*(w_i(\pi_1^*,\pi_2^*),s,P_i),\frac{q_i}{D_i^*}\} \), and
Figure 4  The effects of rising malpractice pressure in jurisdiction 1 on patient access to physicians in both jurisdictions. Malpractice pressure in jurisdiction 2 is such that MCO 2 provides full access to its policyholders.

5.1. Part 1: Jurisdiction 2 at Full-Access

The first numerical exercise examines a set of $P_1$ values $[990, 1189]$ and a single $P_2$ value of 200. As shown in Figure 4, these values are chosen to cover the transition in jurisdiction 1 from full-access to limited-access while jurisdiction 2 provides full-access to its policyholders. Jurisdiction 1 exhibits the same relationship between malpractice pressure and access found in Montanera (2012). MCO 1 provides consumers with a health insurance policy with full access to physicians as long as consumers are willing to pay for it. As malpractice pressure rises, this willingness to pay holds initially, but eventually the cost of maintaining full access becomes so high that consumers would rather keep more of their income for consumption and instead purchase cheaper health insurance with imperfect access to physicians.

As seen in Figure 5, physicians flow into jurisdiction 1 as long as MCO 1 maintains full access in the face of rising malpractice pressure. This means that, even though malpractice pressure is rising in jurisdiction 1, the higher returns from practicing due to increased physician payments are sufficient to drive some physicians to relocate. There are two reasons why an MCO facing rising malpractice pressure might adjust it’s contracts to draw in more physicians. First, the additional
resources brought by the new physicians make each patient less costly to treat. Also, full-access health insurance is cheaper to provide when there are many physicians instead of a few. This is because each physician’s total malpractice liability costs are convex and increasing in $n_i$. This means that two physicians could treat a given number of patients at a lower cost than could one physician. Therefore, rising malpractice pressure induces MCOs to attract more physicians as additional resources and cost savings they bring become more significant.

Even though some physicians flow between jurisdictions in equilibrium, it is clear in Figure 6 that rising malpractice pressure causes two MCOs intent on providing full access to compete for
physicians. Even though malpractice pressure in jurisdiction 2 remains constant, MCO 2 must raise the compensation it provides. This reduces the outflow of physicians and induces the remaining physicians to take on those patients who would have been treated by their departing colleagues. This shows the different ways that the two jurisdictions are affected by rising jurisdiction 1 malpractice pressure. It makes resources, and thus physicians, more valuable to MCO 1. Since MCO 1 is willing to spend to attract these resources, they become more expensive for jurisdiction 2 to retain. Since malpractice pressure in jurisdiction 2 is unchanged, the net benefits to MCO 2 of retaining the physicians and their resources decline, and so some physicians depart in equilibrium. Once malpractice pressure in jurisdiction 1 is high enough to cause MCO 1 to forgo full access, jurisdiction 2 becomes a more favourable option to physicians and this competition decreases. The pattern of effects on health care system quality shown in Figure 7 reflect the flow of physicians. Taking Figures 4 to 7 together, an empirical study with observations at the jurisdiction-level with mobile physicians would uncover effects of malpractice pressure on health care spending biased toward zero, while also inflating the effect on health care quality.

5.2. Part 2: Jurisdiction 2 at Limited-Access

Part 2 performs the same numerical exercise as part 1, with the exception that $P_2$ is held constant at 1500 instead of 200. This increase makes access in jurisdiction 2 costly enough to push jurisdiction
2 into a limited-access solution. As shown in Figure 8, the same pattern of behaviour from MCO 1 has different effects on access in jurisdiction 2 where consumers in jurisdiction 2 are unwilling to purchase full-access health insurance policies. As malpractice pressure rises and MCO 1 maintains full access, it raises physicians’ compensation in order to draw in more physicians. This makes it more costly for MCO 2 to keep physicians in jurisdiction 2. The fact that consumers in jurisdiction 2 prefer limited access to full access shows an unwillingness to pay for better access. As MCO 1 competes for physicians more aggressively, access in jurisdiction 2 becomes more costly to provide, and so MCO 2 substitutes away from health insurance.
Figure 10  The effects of rising malpractice pressure in jurisdiction 1 on health care spending in both jurisdictions when jurisdiction 2 provides limited access.

Figure 11  The effect of rising malpractice pressure in jurisdiction 1 on health care quality in both jurisdictions when jurisdiction 2 provides limited access.

The MCOs’ behaviour creates the same movement of physicians as is part 1. Figure 9 shows that physicians are drawn to the jurisdiction willing to maintain full access as malpractice pressure rises, and then leave the jurisdiction once this willingness is exhausted. As shown in Figure 6, however, the effect of increasing jurisdiction 1 malpractice pressure on health care spending in jurisdiction 2 is the opposite of that seen in part 1. This is because MCO 2, while trying to maintain full access for its consumers, is willing to raise the price of health insurance in order to secure the funds necessary to slow the outflow of physicians. Where consumers in jurisdiction 2 are unwilling to pay for full access, their MCO cannot raise the necessary funds to compete with
the aggressive behaviour from MCO 1. Alternatively, it substitutes away from health insurance by lowering the price and quality of an insurance policy. Once jurisdiction 1 malpractice pressure reaches the point that MCO 1 chooses to provide limited access, the reduction in competitive behaviour makes health insurance less costly to provide in jurisdiction 2. This causes MCO 2 to substitute toward health insurance, thus raising health care spending and quality, as malpractice pressure in jurisdiction 1 increases. Figure 11 shows the effects of this behaviour in health care quality in the two jurisdictions. Since it shows the same pattern as Figure 7, physician mobility creates inflated estimates of malpractice pressure’s effect on quality, regardless of other jurisdictions’ behaviour surrounding access. Figure 10 shows that malpractice pressure’s effect on health care spending are also inflated when other jurisdictions choose to provide their policy holders with limited access; the opposite of the full-access case examined in part 1.

5.3. Part 3: Heterogeneous Jurisdictions, Common Malpractice Pressure

The final numerical exercise examines two jurisdictions that, while facing the same rising level of malpractice pressure ($P_1 = P_2 = P$), contain consumer populations that are different from one another. The purpose is to examine how rising malpractice pressure would differentially affect two distinct populations, between which physicians have some mobility. An obvious application is urban versus rural consumers, and whether physicians’ mobility between urban and rural areas of a state causes the two populations to experience a general rise in malpractice pressure differently from one another$^1$. In the exercise, jurisdiction 1 is more wealthy ($m_1 = 100$) than jurisdiction 2 ($m_2 = 90$).

Consumers with relatively high income have a greater willingness to pay for health insurance than those with low incomes. This is why, in Figure 12, MCO 1 is willing to bear the cost of maintaining full access up until $P = \bar{P}_1$, while MCO 2 must abandon full access at the lower level of $\bar{P}_2$. This yields three distinct ranges of malpractice pressure. As long as $P < \bar{P}_2$, both MCOs choose

$^1$ While these populations may not necessarily rely on separate health insurers, the same bundles would be offered in the case of a single insurer facing potential entrants targeting specific populations
Consumers in jurisdiction 1 have higher incomes than those in jurisdiction 2.

Figures 13 illustrates an important point about physician mobility. As long as the solutions to the two MCOs problems exhibit the same kind of access (full or limited) there is little movement of physicians in equilibrium. For this reason, a lack of observed movement of physicians between jurisdictions does not necessarily indicate that physicians location decisions are unaffected by malpractice pressure. Instead, the lack of movement could indicate a calm surface; where physicians are sensitive to malpractice pressure, but due to escalating or abating competition for physicians
among MCOs, their equilibrium numbers in each jurisdiction are unaffected. When physicians do exhibit mobility in equilibrium, it is from areas or populations that are unwilling or unable to pay the cost of full access to those that are. This offers an explanation for several empirical studies finding that rural populations are particularly subject to outflows of physicians when malpractice pressure increases. This would be the expected outcome since rural areas generally enjoy lower access to health care than do urban areas (Chan et al 2007). Figures 14 and 15 show the same relationships as in parts 1 and 2. Rising malpractice pressure induces an MCO willing to pay for full access to compete for physicians more aggressively. Those unwilling to pay for full access respond by substituting away from health insurance, instead providing less expensive and lower
quality insurance policies and leaving consumers with more income for consumption.

6. Conclusion

Several empirical investigations into the existence and extent of the practice of defensive medicine utilize data at the jurisdiction level. The model specifications used by these studies assumes that the extent of any effect of rising malpractice pressure on health care cost or quality is confined to that jurisdiction. This ignores the potential cross-jurisdictional effects of changes in malpractice pressure, which could introduce bias into estimates of the effects of changing malpractice pressure on health care spending and quality.

The cross-jurisdictional effects uncovered in this paper suggest that physician mobility can inflate estimates of the effect of health care spending on health care system quality. The effect on health care spending can be biased toward or away from zero, depending on other MCOs’ strategies for dealing with competition for physicians. Regarding the differential effects of defensive medicine, the model predicts that for certain ranges of malpractice pressure, competing MCOs will induce mobile physicians to remain immobile in equilibrium. Also, where physicians do relocate, they leave poorer jurisdictions for more wealthy ones, which matches the findings in the empirical literature surrounding the departure of physicians from rural areas to urban areas.

Beyond these results, the cross-jurisdictional effects of changing malpractice pressure supports the idea of a federal role in malpractice reform. Currently, all malpractice reform has been undertaken at the state level. Where cross-jurisdictional effects exist between states, malpractice reform in one state creates external costs and benefits for other states. Since these are not internalized by the state considering the malpractice reforms, the malpractice reform passed in equilibrium is likely to deviate from the socially efficient amount. Therefore, intervention in malpractice liability costs at the federal level could improve matters.
References


