The more the merrier?

Disciplinary actions against malpractice

Limor Hatsor * Artyom Jelnov †

September 3, 2019

Abstract

In a world of experience goods, consumers cannot observe whether low-quality products are a result of malpractice behavior of producers or 'bad luck'. This asymmetric information distorts producers' incentives to exert effort. We introduce two costly ex-post disciplinary actions to alleviate this market failure: consumer malpractice lawsuits and government investigation of malpractice. We examine the role of government effectiveness in detecting malpractice and its transparency in reporting its findings to the public. Our results suggest that 'the more' disciplinary actions is not necessarily 'the merrier', because government intervention crowds-out consumer lawsuits. If the government agency is efficient, it eliminates malpractice on its own. In contrast, an inefficient government agency may be harmful for public health, unless two conditions hold: 1. 'Active' consumers step in and pursue lawsuits. 2. The government is sufficiently transparent.

JEL codes: K13, L15

Keywords: Asymmetric information, consumer protection, malpractice, lawsuits, inspection, product safety, tort law, government effectiveness, transparency

*Jerusalem College of Technology, Israel, limor.hatsor@gmail.com

†Ariel University, Israel, artyomj@ariel.ac.il

We wish to thank Yossi Spiegel, Jonathan Davies, William Shughart for helpful comments and suggestions.

1 Introduction

In a global world with rapidly changing products and technologies, assuring the safety of products is one of the highly intricate challenges of policy-makers . In order to reduce potential risks to consumers, governments struggle to design policies that deter firms (providers or producers) from malpractice behavior. The focus of this paper is ex-post costly government intervention in the form of malpractice investigation (or inspection) by a government agency such as the Ministry of Health (MOH) in Israel or the Food and Drug Authority (FDA) in the United States. We analyze the impact of government intervention and challenge the premise that government intervention always alleviates malpractice of firms. The results depend crucially on the effectiveness of the government in detecting malpractice, on its transparency (or accountability) in reporting its findings, and on the interaction between the government and the consumers who may pursue malpractice lawsuits. The main message of the paper is that the balance between consumer lawsuits and government investigation of malpractice is fragile. Hence, much caution is needed in the pursuit of public health.

We introduce an inspection game where the government agency (or inspector) interacts with firms and consumers. Firms choose their level of effort, or due care, invested in their goods or services, where malpractice (no effort) increases the chance that the good is harmful (damaged or impaired). Then, consumers purchase the products or services and reveal their quality through experience (e.g., patients discover whether their condition has improved or deteriorated after a medical treatment). Given that the product is damaged, the government agency may investigate. The chance that the government inspector detects malpractice depends on the prevalence of its investigation - its choice variable, and on its level of effectiveness (or efficiency) in detecting malpractice, assumed to be exogenously given. In case the government detects malpractice, the consumer is compensated.[1] The government may also discover positive findings about the producer, i.e., that the producer well-behaved and

[1]In many countries, the detection of malpractice by the government is often followed by class actions based on the disclosed evidence.

the damage was caused by nature (or 'bad luck'), not by malpractice. If the government provides a positive feedback about the firm (a public report with positive findings), then the game ends and the consumer is not compensated. In case the government does not publish a report, consumers decide whether to pursue a costly malpractice lawsuit based on their perceived chance to win a lawsuit.

In reality, while negative findings about malpractice of firms are typically published, positive findings may not be publicly reported assuming that they are inessential or of less public interest than negative findings. Taking this possibility into account, we examine the importance of government transparency about positive findings. Based on our results, we argue that government transparency is a key to product safety. Low transparency reduces the chances of consumers to win a malpractice lawsuit (because they are denied information about bad luck of producers). Thus, low transparency crowds-out consumers from pursuing lawsuits and deters producers from exerting effort. In this case, the interaction between the consumers and the government may be harmful for public health.

Note that an efficient government agency deters malpractice on its own and for any level of transparency (and it does not investigate all cases of malpractice). In contrast, an inefficient one must 'work harder' (always conduct a malpractice investigation) and be complemented by 'active' consumers who step in to pursue lawsuits. Nevertheless, if the government is both inefficient and not transparent, its intervention, by crowding-out consumer lawsuits, actually augments the malpractice behavior of firms.

In many instances, it is difficult for consumers to assess before purchase whether products adhere to certain safety standards in a wide array of domains including therapeutic drugs, food, cars, and medical treatment. This asymmetric information between consumers and firms naturally entails potential risks to consumers.[2] Despite the risks, people consume these products constantly. Thus, understanding how to improve the incentives of firms and

[2]To name several examples, home appliances may malfunction and cause damages, and automobile defects may expose passengers to crashes. In the food industry, there is an ongoing debate surrounding the issue of not only the nutritional value of certain products but also their quality and safety.

assure the product safety is of considerable interest to policy-makers.

While typically the effort of firms is unobservable to consumers, they may learn the quality of products from experience (for a review on experience goods see Tirole, 1988).[3] We assume that consequently, consumers may pursue a lawsuit if they suspect in malpractice behavior of the firms. This assumption enriches the classical inspection game with an additional player that may affect the firms' behavior ex-ante.[4] Then, the court follows the standard negligence rule defined in Shavell (2009), "an injurer is held liable for the accident losses he causes ... only if his level of care was less than a level called due care that the courts specify. If the injurer exercised a level of care that equaled or exceeded due care, he will not be held liable".

To assure product safety, many of the markets for experience goods are heavily regulated and supervised by the government.[5] We focus on ex-post malpractice investigation by a government agency that determines whether the firm invested effort (or due care) or not. We show that this policy crowds-out consumers from pursuing lawsuits, as they rely on the government agency to pinpoint malpractice, which in turn augments malpractice behavior of firms. This failure of the government agency to promote public health may be prevented by strictness to appropriate levels of government efficiency and transparency.

Our results interact with another growing literature on online feedback systems. This literature suggests that buyers avoid leaving negative feedback because of seller retaliation and harassment (see e.g., Zervas et al. (2015) on Airbnb).[6] Therefore, silence (no feedback)

[3]Credence goods, on the other hand, are products where consumers, regardless of their experience, never realize their true quality (see the vast literature dating back at least to Nelson (1970) Darby and Karni (1973) and Dulleck and Kerschbamer, 2006).

[4]In Hörner (2002), the discipline of firms is through consumer demand, not lawsuits. Consumers who buy low-quality products may shift their purchases to other firms. Online feedback systems is another disciplinary action that punishes 'bad sellers' by loss of sales (see e.g., Brown and Morgan (2006), Cabral and Hortacsu (2010) and Cai et al. (2014)). In Fishman and Simhon (2005), producers also endogenously decide to invest in the product quality.

[5]For example, governments regulate safety standards or enforce disclosure of information. Dranove and Jin (2010) review the growing volume of literature on the market response to certification and quality disclosure programs. Shavell (1984) shows that safety standards may be lower when customers can sue producers. Hua and Spier (2018) provide conditions for producers' liability to improve welfare, when the vulnerability of customers to accidents is private knowledge.

[6]Using eBay data, Nosko and Tadelis (2015) construct a measure for sellers' quality (the number of positive feedback transactions divided by the total number of transactions) that penalizes sellers who are

is bad news for consumers because it is equivalent to negative feedback to some extent.

In the context of government ex-post investigation of malpractice, we show that silence (low transparency) of the government about its positive findings is bad news for consumers and may have detrimental effects in the equilibrium. Being denied positive feedback about the firms, consumers have lower chances to win a malpractice lawsuit, which crowds them out from pursuing lawsuits. They realize that in case of silence, the positive findings will be discovered in court and they will not be compensated. Therefore, in the context of government inspection, the result that silence is bad news for consumers is endogenously reinforced in our model.

The remainder of the paper is organized as follows. Section 2 provides background for our model. Section 3 describes the economic framework and our results. Section 4] contains concluding remarks and discussion. Most of the proofs and detailed description of the data are relegated to the Appendix to facilitate the reading. Note that the Appendix also provides a review of stylized facts on medical malpractice investigation systems and possible channels for government inefficiency in Israel and in the United States.[7]

2 Background

In this section we use several worldwide datasets to assess the relation between the efficiency of the government and safety outcomes across countries, a non-trivial link that corresponds to our results. We focus on road safety outcomes, a main challenge for policy-makers. First, we plot road safety outcomes, measured by road fatalities per 100,000 population, VS worldwide indicators of government efficiency across countries. See a full description of the indicators and the data sources on the Data Appendix.

associated with more transactions for which the buyers left no feedback.

[7]We thank Jonathan Davies, a former principal editor of the journal 'Medicine and Law' (Hebrew), for a useful review of case studies on medical malpractice.

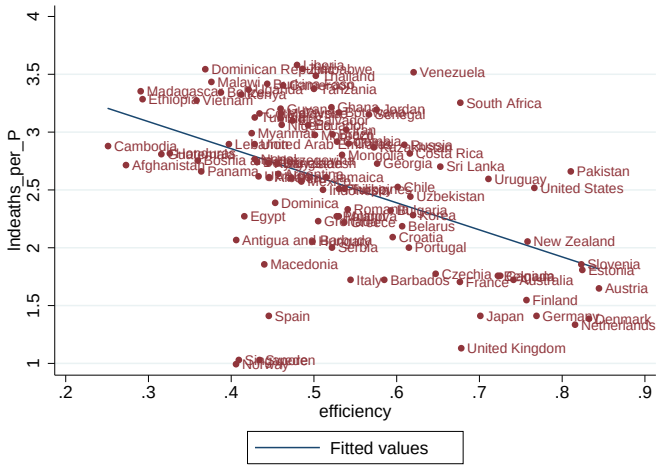

Figure 2.1: Number of road fatalities per 100,000 population (in log values) VS the indicator for government efficiency in 103 countries. Sources: Global status report on road safety 2015, World Health Organization; the World Justice Project (WJP) Rule of Law Index 2017-2018 report

Not surprisingly, Figure 2.1 shows suggestive evidence that in countries with higher levels of government efficiency the estimated number of road fatalities is relatively low.[8] We further split the data into two sub-samples of countries by the median efficiency level of the sample, 0.51, and repeat the exercise.

[8]Similar graphs are obtained using a different dataset on the railroad sector (Appendix B figure 4.4).

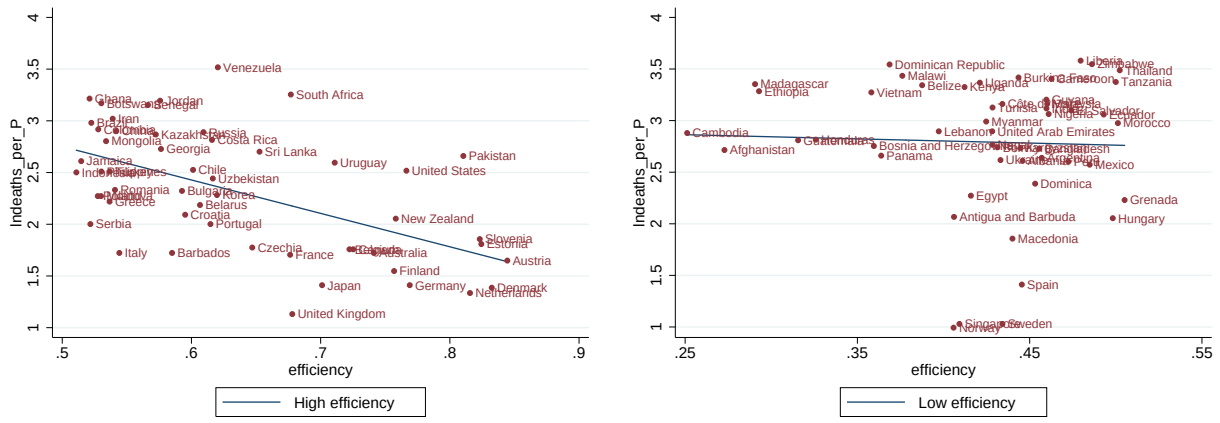

Figure 2.2: Number of road fatalities per 100,000 population (in log values) VS the indicator for government efficiency for countries above the median efficiency level ('high efficiency') and countries below the median ('low efficiency'). Sources: Global status report on road safety 2015, World Health Organization; the World Justice Project (WJP) Rule of Law Index 2017-2018 report.

The impression from Figure 2.2 is that government efficiency is a main factor in road safety outcomes only in countries with high efficiency levels (above the median of 0.51). In countries with low efficiency levels the regression line is flat, implying that there may be other factors involved. To verify our impression, we run regressions of road fatalities on government efficiency controlling for GNI per capita for the two sub-samples of 'high' and 'low' efficiency countries (see Appendix B, Figure 4.3). Consistent with Figure 2.2, the regressions yield a significant negative relation between the level of government efficiency and the number of road fatalities for the high efficiency sample, whereas the coefficient of efficiency is insignificant and overall the regression is rejected in the low efficiency sample.

This suggestive (although not causal) evidence is consistent with the main results of our model. That is, when the government efficiency is high, the government eliminates the malpractice of providers on its own (in the case of road accidents, the 'providers' of road safety are construction companies and drivers). However, in case of low government efficiency, the government intervention does not necessarily foster safety outcomes. The total effect depends on other parameters, including the government's level of transparency

(or accountability) and its interaction with consumers. See Figures 4.4 and 4.5 in Appendix B for more suggestive evidence about government accountability and its association with safety outcomes.

3 The Model

We present the model in three steps. We start from a basic model as a benchmark for further analysis. Then, we add a government agency (such as the MOH in Israel or the FDA in the US) that performs ex-post malpractice investigation. Last, we examine the effect of asymmetric information about the effectiveness of the government.

3.1 A model without government intervention

Let P be a firm (provider or producer) that produces a product (or distributes a good or a service), and denote by C a consumer who buys the product or service. The firm P chooses to either exert effort (e) or not (ne), where the action chosen is a private knowledge of P.[9] We assume that if no effort is exerted (the case of firm's malpractice), then the firm produces a damaged product. If the firm exerts effort, then there is a positive probability that the product is undamaged α, $0 < \alpha < 1$. But despite the effort there is still a chance $1 - \alpha$ that the product is damaged (which we also refer to as 'bad luck'). For example, when doctors exert effort, there is still a chance that the patient's condition worsens after the medical treatment. That is, there is still room for 'bad luck' which doctors are not held accountable for.

If the product is undamaged, then the game ends. If the product is damaged, then the customer C decides whether to pursue a malpractice lawsuit against the firm (s) or not (ns). Note that although the consumers observe the damage, their decision is taken under

[9]The effort of firms may manifest in different stages of production or distribution of goods and services, through e.g., the choice of technologies or inputs or its level of self-monitoring.

uncertainty, because they cannot observe the effort level of the firms (or distinguish bad luck from malpractice).

The consumer payoff increases with the product quality. Specifically, while a high-quality product generates a maximal payoff 1 to the consumer, a low-quality product yields a payoff 0 to the consumer in case she does not pursue a lawsuit. If the consumer decides to sue, then she pays an nonreturnable lawsuit cost c, $c > 0$, that includes court fees and cost of experts and lawyers. We assume that a lawsuit reveals the effort level of the firm (or equivalently whether the damaged product is a result of malpractice (ne) or bad luck (e)). We discuss relaxation of this assumption later. Accordingly, if the malpractice lawsuit is justified, that is the firm chose (ne), then the consumer C obtains a compensation of b for the malpractice, namely, the net payoff of C is $b - c$.[10] If the provider well-behaved (or (e) was chosen), then the consumer malpractice lawsuit is rejected by the court (but the consumer still pays the lawsuit cost c).

Definition 1. *Active consumers.*

Consumers are active if a justified lawsuit yields a positive net payoff for the consumers, i.e., $b - c > 0$ (the compensation, b, is larger than the cost, c). Otherwise, consumers are inactive, that is they trivially never pursue lawsuits.

Consumers may play a role as a disciplinary body if justified lawsuits yield a positive net payoff. Otherwise, if $b < c$, (ns) is their dominant strategy. The payoff of the firm P depends on the occurrence of malpractice and whether it is discovered. The firm receives the largest payoff 1 if no effort was made (ne) and the consumer did not pursue a lawsuit (ns). A justified lawsuit (in case of malpractice) reduces the provider's payoff to 0. That is, the penalty on the firm in case of a justified lawsuit is 1. If the provider well-behaved ((e) was chosen), then its payoff is always x ($0 < x < 1$, whether it is sued or not). It follows that the cost of effort for the provider is $1 - x$. This defines a game Γ_1 (see Figure 3.1). Denote

[10]Note that while not necessary for our results, justice requires that the net payoff should not exceed the damage to the consumer, or $b - c \leq 1$.

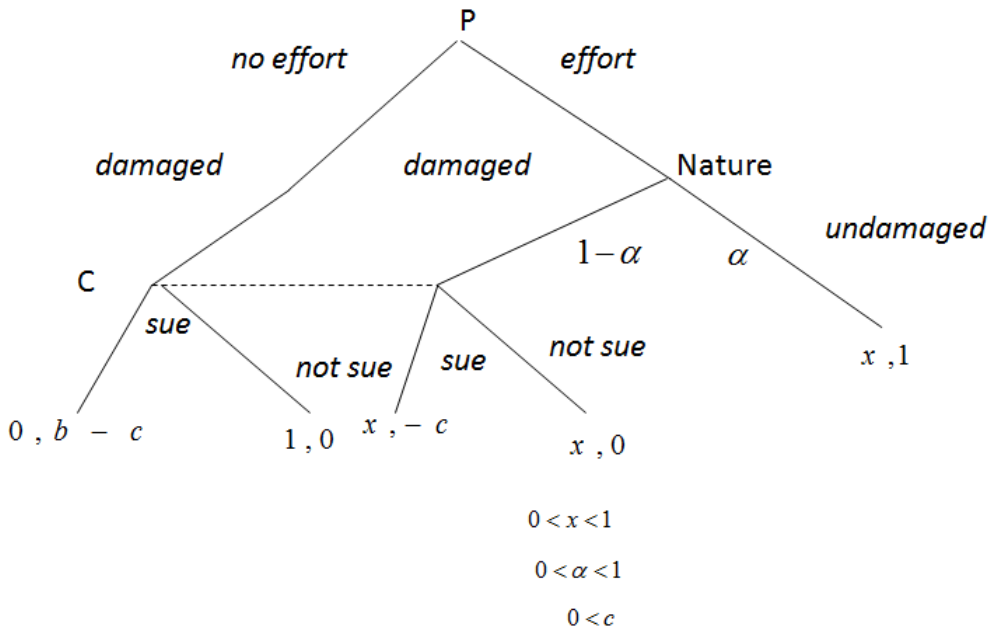

Figure 3.1: Γ_1. In each pair of payoffs the first number denotes the payoff of the firm P, and the second one is the payoff of the consumer C.

by P_e the probability that the producer P chooses (e) and by P_s the probability that the consumer C chooses (s) given that the product is damaged. Then, the equilibrium of this game is characterized as follows,

Proposition 1. *The equilibrium with active consumers and no government intervention.*

The equilibrium is unique with mixed strategies, $0 < P_e < 1$ and $0 < P_s < 1$,

$$P_s = 1 - x \tag{1}$$

$$P_e = \frac{b - c}{b - \alpha c} \tag{2}$$

Proof See Appendix.

According to Proposition 1, when consumers are active, it is worthwhile for then to pursue lawsuits (in a positive probability P_s), and consequently there is a positive probability P_e that providers excel effort. In other words, the chance of being sued by consumers encourages

providers to well-behave.

Note that the probability of consumers to sue increases in the cost of effort of the firms, $1-x$, in order to maintain the indifference of the firms between (e) and (ne). Additionally, the probability of the providers to excel effort rises in b–c (the net payoff of consumers in case of a justified lawsuit), in order to maintain the indifference of consumers between (s) and (ns). A similar argument applies to an increase in α, which augments $P(ne|l)$ (the chance of malpractice given that the product is damaged).

There are also several trivial results. If the consumers are inactive $(b < c)$, then trivially they never pursue lawsuits, and as a result providers never exert effort, (ns) and (ne). The same equilibrium occurs if effort yields a negative payoff to firms $(x < 0)$. Similarly, if lawsuits are free $c = 0$, then consumers always pursue lawsuits and providers always exert effort, (s) and (e).

An attendant question is how a government agency that investigates malpractice may affect the incentives of providers to well-behave. We argue in the sequel that the result depends on the level of efficiency and transparency of such an institution.

3.2 A model with government intervention

In this section, we add a government agency (an inspector) denoted by R that may perform a costly investigation of malpractice if the product is damaged. The cost of investigation is c_R, $c_R > 0$. We define the game Γ_2 as an extension of Γ_1. The inspector R moves first and commits to investigate the firm (i) with probability P_i in case the product is damaged ($1-P_i$ is the chance that an investigation does not take place (ni), respectively). The probability P_i is known to the firm P.[11] Customers typically do not encounter the inspector on a regular basis, and thus we assume that they are not informed about P_i. Then, the firm chooses whether to excel effort (e) with probability $P_e(P_i)$. If the product is undamaged, the game

[11] Alternatively, the firm may learn P_i from its past interaction with the inspector. A model with an inspector as a first mover appears in Andreozzi (2004).

ends. In this case, the payoffs of P and C are as in the game Γ_1 and the payoff of R is 1.

We assume that the government's goal is to promote public health (or equivalently, to promote product safety by reducing the malpractice of firms). Accordingly, the inspector's payoff (EU_R) equals the expected consumer payoff net of the expected cost of investigation. That is, in case that the product is undamaged, the payoff of R is 1. If the product is damaged, then its payoff is 0 if no investigation was performed, else it pays the cost of investigation c_R. Formally,

$$EU_R = \alpha P_e(P_i) - c_R(1 - \alpha P_e)P_i. \tag{3}$$

Given that investigation is performed by R and that malpractice indeed occurred, she detects the malpractice (ne) with a positive probability r, $0 < r < 1$, assumed for now to be common knowledge in the economy. The parameter r can be viewed as measuring the level of effectiveness, or efficiency, of the government agency in detecting malpractice. We define the inspector as efficient if its chance to detect malpractice is sufficiently high.

Definition 2. *Efficiency of the government.*

The government inspector is efficient (or effective) if its probability to detect malpractice is sufficiently large, $r > 1 - x$. Otherwise, the inspector is inefficient.

If the government inspector R detects malpractice, then the game ends. The consumer is compensated by b and a penalty of 1 is imposed on the provider. However, the investigation may also yield positive findings (reveal that the damaged product is a result of bad luck and the firm well-behaved). In reality, positive findings about the effort of the firm may not be publicly reported quite often. To take this possibility into account, we define an exogenous parameter t ($0 \leq t \leq 1$, t is commonly known) that measures the level of government transparency (or accountability) about positive findings. Formally, given that R reveals that the firm exerted effort, t measures the probability that it releases a positive report to the

public. Accordingly, the inspector is *more transparent* as higher the parameter t is, where $t = 1$ denotes *full transparency*, and $t = 0$ denotes *no transparency*.

Definition 3. *Transparency of the government.*

High transparency level of the government inspector is denoted by $t > r$. Low transparency is denoted by $t < r$.

If the government provides a positive report about the firm, then the game ends, no compensation is paid to the customer, and the firm obtains x. However, if the government agency does not release a report, the game is back to the consumer decision whether to pursue a malpractice lawsuit. At this point, the consumers are uncertain about their chances in court because they cannot distinguish between three cases: First, there is a chance $1 - P_i$ that R did not perform an investigation. Second, if R performed an investigation, there is a chance $1 - r$ that the investigation was unsuccessful to detect malpractice. Third, there is a chance $1 - t$ that the inspector was not transparent about positive findings. Under this uncertainty about the inspector's performance, C decides whether to pursue a malpractice lawsuit. Then, the game proceeds as Γ_1, see Figure 3.1. Let us define thresholds for the government investigation cost.

Definition 4. *Thresholds for the government investigation cost.*

Define,

$$c_R^* = \frac{\alpha r}{(1-x)(1-\alpha)}$$

,

$$c_R^{**} \equiv \alpha \frac{(b-c)(1-r)}{(1-\alpha)((1-r)(b-c)+c(1-t))}$$

The following proposition characterizes the equilibrium under an efficient government agency.

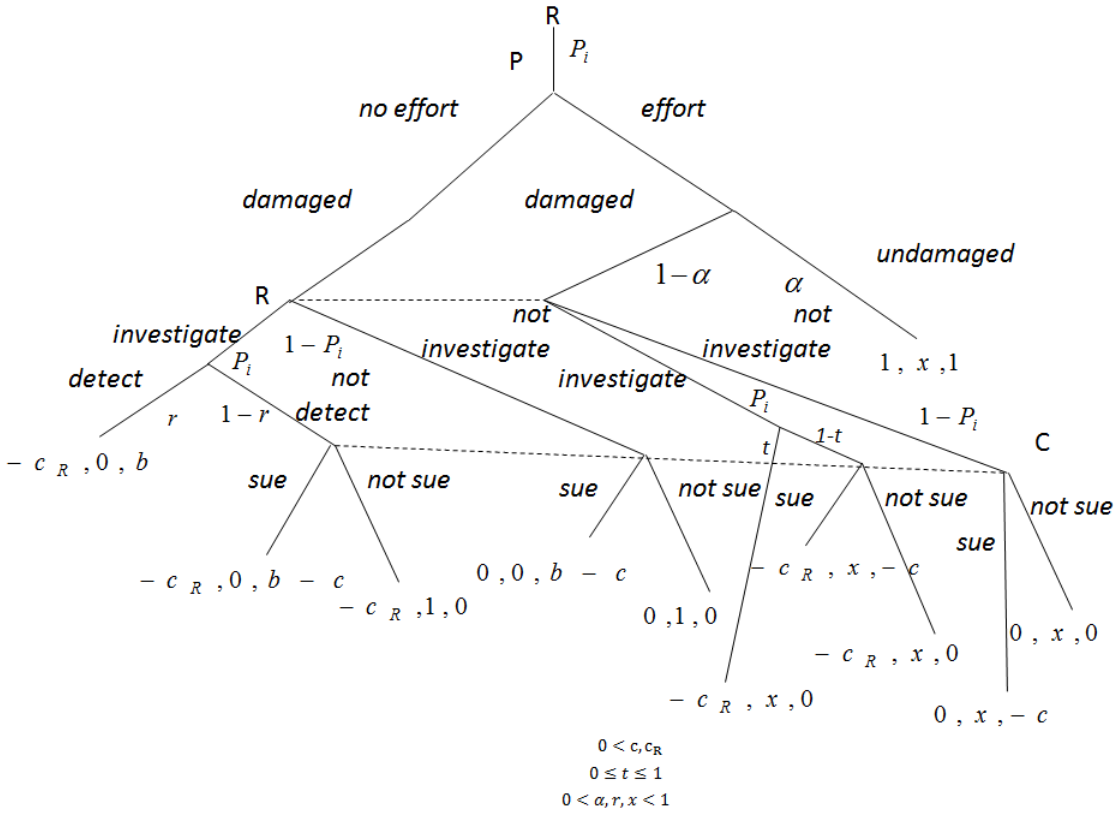

Figure 3.2: Γ_2. In each triple of payoffs the first number is the payoff of R, the second one is the payoff of P, and the third one is the payoff of C.

Proposition 2. *The equilibrium with an efficient government inspector and* $c_R < c_R^*$.

In the unique equilibrium the inspector prevents malpractice completely on its own, pure (e) and (ns), with a positive chance of inspection, $P_i = \frac{1-x}{r} < 1$.

Proof See Appendix.

An efficient government agency prevents malpractice completely on its own. That is, the government agency fully substitutes the consumers as a disciplinary body, and consumers never pursue lawsuits (even if they are active). The chance to be investigated by an efficient inspector is sufficient to guarantee the effort of providers without the need for additional disciplinary actions by the consumers. However, if the inspector is inefficient, then consumer lawsuits become a crucial disciplinary action to alleviate malpractice behavior.

Proposition 3. *An inefficient inspector or* $c_R > c_R^*$ *and inactive consumers.*

In the unique equilibrium, no disciplinary actions are taken, pure (ni) and (ns), which 'guarantees' malpractice behavior of firms, pure (ne).

An inefficient inspector without active consumers 'guarantees' malpractice. No disciplinary actions are taken against the provider ((ns) and (ni)), and the equilibrium collapses to the worst scenario in terms of public health ((ne) by the provider). In contrast, an inefficient government agency accompanied by active consumers (who step in to pursue lawsuits) may provide some incentives against malpractice. Assume in the rest of this section that the cost of investigation is sufficiently low, $c_R < {c_R^*}^*$ and $t < 1$.

Proposition 4. *The equilibrium with an inefficient inspector and active consumers.*

In the unique equilibrium, compared to an efficient inspector,

1. More disciplinary actions are taken, $P_s = \frac{1-x-r}{1-r}$, $P_i = 1$.
2. Malpractice is alleviated but not prevented, $P_e = \frac{(b-c)(1-r)}{(b-c)(1-r)+c(1-\alpha)(1-t)}$. .

Proof See Appendix.

Comparing propositions 3 and 4 reveals that active consumers is a key to alleviate malpractice behavior of firms. When justified lawsuits are worthwhile for consumers, both disciplinary actions play a role (consumer lawsuits and government investigation), and together they alleviate malpractice behavior of firms to some extent.

Comparing propositions 2 and 4 reveals that an inefficient inspector (accompanied by active consumers) 'works harder' than an efficient inspector in the sense that it investigates all cases of damaged product. That is, its inefficiency is partially compensated by more disciplinary actions - a larger chance of investigation as well as consumers who pursue lawsuits. However, although more disciplinary actions take place, they are less successful in alleviating malpractice than an efficient inspector on its own. While an efficient inspector prevents malpractice completely, an inefficient inspector with the 'assistance' of consumer lawsuits partially prevents malpractice and cannot achieve pure (e).

The success of an inefficient inspector to alleviate malpractice depends crucially on its level of transparency t. A higher level of transparency implies a larger probability that providers exert effort. The reason is that more transparency increases the chance of consumers to win a malpractice lawsuit (more transparency means a lower chance that the government did not report its positive findings, and thereby a higher chance that malpractice indeed occurred). Their larger chances in court encourage the consumers to pursue lawsuits and in turn, induce the firms to exert effort (which maintains the indifference of consumers between (s) and (ns)). The positive relation between the level of transparency and the chance that firms exert effort implies that low transparency may have detrimental effects on the public health.

Proposition 5. *An inefficient inspector and active consumers - the effect of transparency.*

Compared to the equilibrium without government intervention,

1. Malpractice is alleviated if the government transparency is high, $P_e > \frac{b-c}{b-\alpha c}$ if $r < t$.
2. Malpractice is augmented if the government transparency is low, $P_e < \frac{b-c}{b-\alpha c}$ if $t < r$.

Proof See Appendix.

Comparing the equilibrium with and without an inspector emphasizes that 'the more' is not necessarily 'the merrier'. Implementing investigation of malpractice by an inefficient government agency alleviates malpractice behavior of firms only if it is highly transparent ($t > r$). Otherwise, an inefficient inspector with low transparency ($t < r$) is harmful for public health (augments malpractice) relative to the case of no government intervention.

The intuition lies on the consumer response to the government intervention. The government intervention crowds-out consumer lawsuits ($P_s < 1-x$). When the level of transparency is low, being denied positive findings about the firms, consumers have lower chances to win malpractice lawsuits. They realize that the potential positive findings will be discovered in court and they will not be compensated. Therefore, they rely on the government inspector and crowd-out from pursuing lawsuits, which in turn reduces the probability that firms exert effort (below its level without government intervention). Thus, in our framework the transparency of the government agency is highly important for its pursuit of public health.

It is important to note, that consumers may prefer the presence of an inefficient and not transparent inspector (that augments the malpractice behavior of the firms), because they may save the cost of a lawsuit. That is, if the inspector detects malpractice, they will be compensated without having to pay the nonreturnable lawsuit cost. The expected payoff of the consumer C in game Γ_1 (without government intervention) is by Proposition 1

$$EU_C = \alpha P_e. \tag{4}$$

The expected payoff of the consumer in game Γ_2, with an inefficient and not transparent ($t = 0$) government intervention (see Proposition 4) is

$$EU_C = \alpha P_e + br(1 - P_e). \tag{5}$$

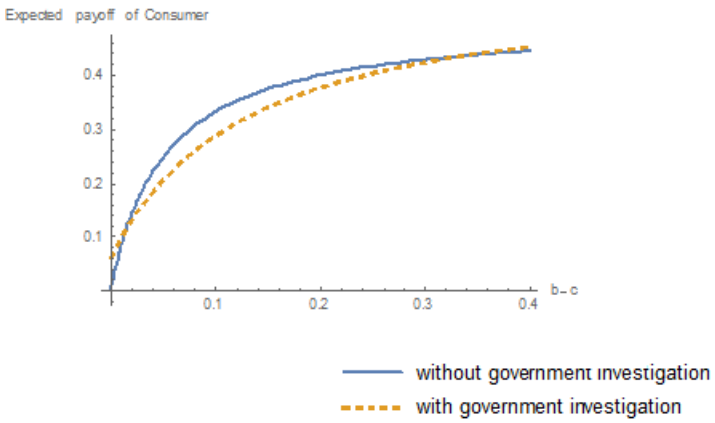

Figure 3.3: Expected payoff of C for $\alpha = 0.5$, $c = 0.1$, $r = 0.6$, $c_R < c_R^*$, $x < 1 - r$.

In Figure 3.3 we provide a numerical example that compares equations (4) and (5) for the case that the inspector is inefficient and not transparent. The example indicates that when the net payoff of the consumer in case of a justified lawsuit $(b - c)$ is sufficiently high (above 0.35 in the numerical example), then consumers are better off with government intervention because of the chance they may be compensated without the need to pay the lawsuit cost.

Note that while in this section, we consider only equilibria where R uses pure strategies, namely, selects some P_i with probability one, a full characterization of the equilibrium of Γ_2 appears in Proposition 8 in the Appendix. In the following section, we analyze the effect of asymmetric information with respect to the effectiveness of the inspector.

3.3 A model with inspection and asymmetric information

In reality, most consumers do not know the precise level of effectiveness of the inspector. Suppose that only R and P know the level of government efficiency, r. C does not know the level of r but has a prior on the distribution of r, $G : [0, 1] \to [0, 1]$. Assume also that consumers are active and $t = 0$. This game is denoted as Γ_{asym}. We consider two cases. In the first case, consumers believe with high probability that the inspector R is efficient. Then, if the inspector is indeed efficient, it prevents malpractice completely and

we obtain the equilibrium described in Proposition 2 (pure (e) and (ns)). However, when the inspector is less efficient than expected, the asymmetric information about the level of r may be harmful for the public health (augment malpractice).

Proposition 6. *Harmful asymmetric information, when efficiency is lower than expected.* Assume that the consumer believes with high probability that the inspector R is efficient, $G(r \leq \max[1-x, \frac{c_R(1-\alpha)}{\alpha}(1-x)]) < \frac{c}{b}$. Then,

$$P_i = \begin{cases} \frac{1-x}{r} & , r \geq \max[1-x, \frac{c_R(1-\alpha)}{\alpha}(1-x)] \\ 0 & , otherwise \end{cases}$$

$$P_e = \begin{cases} 1 & , P_i \geq \frac{1-x}{r} \text{ and } r \geq \max[1-x, \frac{c_R(1-\alpha)}{\alpha}(1-x) \\ 0 & , otherwise \end{cases}$$

and $P_s = 0$.

Proof See Appendix.

The intuition is straightforward. When consumers believe that with high probability the inspector is efficient, they behave as though the inspector is certainly efficient (as in Proposition 2). That is, they rely on the inspector and crowd-out from pursuing malpractice lawsuits assuming that the providers exert effort. Naturally, when the realization of r is sufficiently low, $(r < \max[1-x, \frac{c_R(1-\alpha)}{\alpha}(1-x)])$, the reliance of the consumers on the inspector is unjustified and (given that consumers do not sue and in turn the inspector does not inspect) malpractice occurs with certainty (as in proposition 3, P chooses pure (ne), lower than if r is common knowledge). In this case, public information about r would shift the equilibrium into a positive probability that firms exert effort (as in proposition 4).

Next, we examine a second case, where consumers know that the inspector is inefficient but cannot observe the level of r. In this case, the asymmetric information may be beneficial for public health (discourage malpractice).

Proposition 7. *Beneficial asymmetric information when efficiency is larger than expected.*

Assume that the inspector is one of two inefficient types ($r_{max}, r_{min} < 1 - x$).

The consumer assigns probabilities (θ, $1 - \theta$) to these types, respectively.

Then,

if c_R and θ are sufficiently low but R is of type r_{max}, in the equilibrium P chooses pure (e), a higher probability than if $r = r_{max}$ is common knowledge.

Proof See Appendix.

As we previously discussed, when the inspector is inefficient and consumers know r, malpractice is alleviated but not prevented completely (recall proposition 4). Nevertheless, when consumers believe that there is a high chance that the realization of r is low (r_{min}), they step in and pursue lawsuits with a high probability, which induces the firms to well-behave. Then, if the realization of r is indeed high (r_{max}), providers behave as though the inspector is efficient and excel effort with certainty (as in proposition 2).

4 Discussion

We study how the interaction between two disciplinary actions affects the malpractice behavior of producers. Comparing the equilibrium under different levels of government efficiency and transparency provides two main insights. First, we show that government intervention may lead to more malpractice of firms, because it crowds-out consumer lawsuits. However, if the government is sufficiently effective in detecting malpractice or sufficiently transparent about its positive findings, then its intervention may be beneficial for public health. The second insight is that while an efficient government agency eliminates malpractice on its own, an inefficient one must 'work harder' and be complemented by 'active' consumers who step in to pursue lawsuits.

Next, we discuss some of our assumptions. We assume that the court's chance to discover malpractice behavior is larger than the inspector's (without loss of generality, the court

always discovers malpractice). This assumption is quite plausible in our framework, where the court always plays after the inspector, and thereby can use at least all the information collected by the inspector. This is more prevalent in the continental juridical system, where the court, following a lawsuit, may initiate its own investigation and collect evidence (on top of the inspector's and the parties').

To examine this assumption, in Appendix A we plot two indicators taken from the World Justice Project (WJP) for 113 countries, 'government efficiency' (in blue) and 'civil justice efficiency' (in red) (See full description of the indicators and the data sources in the data Appendix). The impression is that typically the civil justice efficiency score is larger than the government efficiency score, consistent with our assumption. Additionally, we reject the hypothesis of equality of means of these indicators for a P-value of 7%.

Moreover, suppose that we assume more realistically that the court is not perfect, namely, the court discovers malpractice with some probability $q < 1$ (that measures the efficiency of the court). Then, the results are robust for the no transparency case ($t = 0$) and for a sufficiently high court efficiency, q. However, if both the court efficiency and the government efficiency (q and r) are low, there is an additional equilibrium where consumers do not step in to pursue lawsuits and no disciplinary actions take place (ni and ns). Consequently, the provider makes no effort (ne).

Another assumption about the court is that providers who invest effort are not immune to lawsuits but are never mistakenly convicted by the court (no type-I error). Assuming alternatively that they may be mistakenly convicted does not change our results qualitatively. Though, in this case a more complicated model may be considered, where the provider and the customer bargain on the compensation to the customer. For example, in Daughety and Reinganum (2011) the plaintiffs and the producer reach a settlement.

Other assumptions of our model involve the government. The government agency commits to a probability of investigation. Assuming instead that the inspector decides whether to inspect or not after observing a damaged product does not change the results qualita-

tively besides the following exception. In this case, there is no equilibrium where effort is guaranteed.

Our assumption that the customer does not know the probability of investigation is crucial for the results. Otherwise, the customer's best reply depends on the probability of investigation. Then, the game Γ_1 is a subgame of Γ_2, when the government decides not to investigate (ni). However, our results are robust to a slight modification of the model, where it is commonly known that inspection of malpractice is mandatory in every case of damage. This may be plausible when the potential damage is extremely severe, e.g., when sensitive food is involved.

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Data Appendix

This section describes our data sources, all publicly available, and the indicators we use.

Government efficiency -

We use the World Justice Project (WJP) Rule of Law Index 2017-2018 report drawn from the assessments of more than 110,000 citizens and 3,000 legal experts in 113 countries and jurisdictions. Each score of the Index is calculated using a large number of questions from two original data sources collected by the World Justice Project in each country: a General Population Poll (GPP) and a series of Qualified Respondents' Questionnaires (QRQs). They capture the experiences and perceptions of ordinary citizens and in-country professionals in their country, where 1 signifies the highest score and 0 signifies the lowest score. The report presents 8 composite factors that are further disaggregated into 44 specific sub-factors. For our purpose, we use several sub-factors. First, the indicator for government efficiency, sub-factor 6.1, measures the extent to which 'Government regulations are effectively enforced', where government regulations include e.g., labor, environmental, public health, commercial, and consumer protection regulations. This factor does not assess which activities a government chooses to regulate, nor does it consider how much regulation of a particular activity is appropriate. An alternative measure that provides similar qualitative results is sub-factor 6.3 that measures whether administrative proceedings are conducted without unreasonable delay at the national and local levels.

Civil Justice efficiency -

We take the indicator for Civil Justice efficiency from the same dataset, the WJP Rule of Law Index, and it is similarly measured by sub-factor 7.6, 'Civil Justice is effectively enforced'. This indicator examines if decisions are enforced effectively, the effectiveness and timeliness of the enforcement of civil justice decisions and judgments in practice. Correspondingly, an alternative measure that provides similar qualitative results is sub-factor 7.5 that measures whether court proceedings are conducted (and judgments are produced) without unreason-

able delays.

Rail safety -

Railway safety data are collected by the European Union Agency for Railways through the Common Safety Indicators. For our purpose, we use the number of victims in rail accidents to measure the safety of rail transport, available for 19 countries. To obtain a measure for relative safety, the number of victims must be linked to traffic performance. Therefore, the number of victims is divided by ton-kilometers. A ton-kilometer is a unit of measure of freight transport which represents the transport of one ton of goods (including packaging and tare weights of intermodal transport units) by rail over a distance of one kilometer. Only the distance on the national territory of the reporting country is taken into account for national, international and transit transport. We obtain qualitatively similar results using the number of rail accidents instead of the number of victims, or passenger-kilometers instead of ton-kilometers. A passenger-kilometer is a unit of measurement representing the transport of one passenger by rail over one kilometer.

Road safety -

We use the Global status report on road safety 2018, World Health Organization, P. 264, table A2. The variable of interest is the estimated road traffic death rate per 100 000 population. The global status report on road safety has been developed through an iterative and consultative process with participating Member States.[12]

Gross National Income (GNI) -

Our data source is the World Development Indicators database, World Bank, November 2017. GNI per capita is the dollar value of a country's final income in a year divided by its

[12]In the first phase, requests for data were sent out through a survey administered by the WHO Headquarters to Regional and National Data Coordinators (R/NDC) appointed in each region or country. With coordination by the NDCs, experts from different sectors within each country discussed the responses to the survey questions. Based on the reported number of road traffic deaths and the source of data, adjustments were made to account for potential under-reporting due to differences in definitions as well as limitations in the Civil Registration and Vital Statistics in many countries. This process resulted in an estimated number of fatalities. Following this, a final consultation was carried out to allow Member States to respond to any changes that resulted from the verification and validation process.

population.

Accountability -

We use the OECD indicators for management practice of Sector inspectors. The data include measures of the governance of the bodies that design, implement and enforce the regulations on six network sectors, including railroad transport infrastructure data on 17 countries. The indicator of accountability is constructed by the OECD as a weighted average of 9 questions that measure the accountability of the inspector towards various stakeholders, including the government, the regulated industry and the general public. It directly draws on the first, fourth and fifth governance principles, asking, for instance, to whom the inspector is accountable by statute, whether it collects and publishes various types of performance information, whether it publishes a report on its activities and whether it engages in public consultations and hearings. The indicator's range is 0-6, where a country score of '0' represents the largest level of 'accountability' and '6' denotes the smallest value of the indicator. Figure **??** provides detailed description of the questions and their weights. It is taken from the 'Schemata sector inspectors' on the OECD website. It describes each question and its weight in the construction of the 'accountability' indicator,
http://www.oecd.org/eco/reform/indicatorsofproductmarketregulationhomepage.html

Table 1. **Accountability**

	Question weight a_i	Subquestion weight b_j	Coding of answers			
To whom is the regulator directly accountable by law or statute?	1/9			parliament 0	government or representatives from regulated industry 6	
Are the duties/objectives of the regulator defined in law/published?	1/9			yes 0	no 6	
Does the regulator need to submit proposals for new regulation to other bodies for approval?	1/9		to the parliament 3	to the government 6		no 0
Through which body can the decisions of the regulator be appealed in the final instance?	1/9		court 0	special body 3	ministry 4.5	regulator itself 6
Is there a legislative requirement for the regulator to produce a report on its activities on a regular basis (e.g. annual) and is this report published online?	1/9			yes 0	no/not applicable 6	
Does the regulator collect the following performance information?	1/9					
Industry and market performance		1/7		0	6	
Operational/service delivery		1/7		0	6	
Organizational/corporate governance performance		1/7		0	6	
Quality of regulatory process		1/7		0	6	
Compliance with legal obligations		1/7		0	6	
Economic performance		1/7		0	6	
Financial performance		1/7		0	6	
If such performance information is collected, is it available via the internet?	1/9			0	6	
Are the costs of operating the regulator published and accessible to the public?	1/9			0	6	
Are the following legislative requirements in place to enhance the transparency of the regulator's activities?	1/9					
Publication of all decisions, resolutions and agreements		1/4		0	6	
Public consultation on relevant activities		1/4		0	6	
Publication of a report on the regulators activities		1/4		0	6	
Publication of a forward-looking action plan		1/4		0	6	
Country scores (0-6)			$\Sigma_i a_i \Sigma_j b_j$ answer$_{ij}$			

Appendix A: Medical malpractice

In this section, we review stylized facts on ex-post medical malpractice investigation systems and possible channels for government inefficiency in Israel and in the United States. Our focus on medical malpractice emanates from the gravity of the problem, medical error is argued to be the third leading cause of death in the US according to the British Journal (Makary and Daniel, 2016).

Ombudsman VS. Courts

In Israel, the Ombudsman at the MOH processes the public complaints on medical malpractice and considers whether to establish an investigation committee. After investigation committees submit their conclusions, the director general decides whether to transfer the case to the disciplinary department for further disciplinary actions.

Year	Number of complaints	Number of investigation committees	Percentage of investigation committees	Decisions in disciplinary committees				
				Total	Acquittal	Conviction		
						Censure	warning	License suspension
2008	1,175	46	3.91	-	-	-	-	-
2009	1,075	22	2.05	-	-	-	-	-
2010	1,026	41	4.00	-	-	-	-	-
2011	1,096	48	4.38	-	-	-	-	-
2012	1,130	43	3.81	10	2	1	1	6
2013	-	-	-	8	1	0	1	6
2014	1,292	40	3.10	3	0	0	0	3
2015	1,298	40	3.08	8	1	0	1	6
2016	1,277	40	3.13	3	2	1	0	0
total	**9,369**	**320**	**3.42**	**32**	**6**	**2**	**3**	**21**

Figure 4.1: Medical practice investigation in the Ministry of Health (MOH), Israel. Source: Authors calculations based on tables 5-6 in the report of the research center of the Israeli congress (2017, p.23,25)

According to Figure 4.1, there were about 1,000 complaints on medical malpractice per year (a total of 9,369) in the years 2008-2016. A total of 320 investigation committees were established for only 3.42% of these complaints (2.05%-4.38% per year). Data on both investigation commeetis and disciplinary committees is available for the years 2012-2016 (excluding 2013). During this period, a total of 24 disciplinary committees were established, which is 14.8% from a total of 163 investigation committees and only 0.5% from a total of 4,997 complaints submitted to the MOH. Most disciplinary committees ended in license suspension.

Suggestive evidence seems to support the view that the magnitude of this process is relatively small compared to consumer lawsuits. According to private lawyers, they usu-

ally recommend their customers to refrain from submitting complaints to the MOH and pursue medical malpractice lawsuits instead, given the considerable duration of time and non-exhaustion of the process (see report 62 of the State Comptroller of Israel, 2011, p. 260).

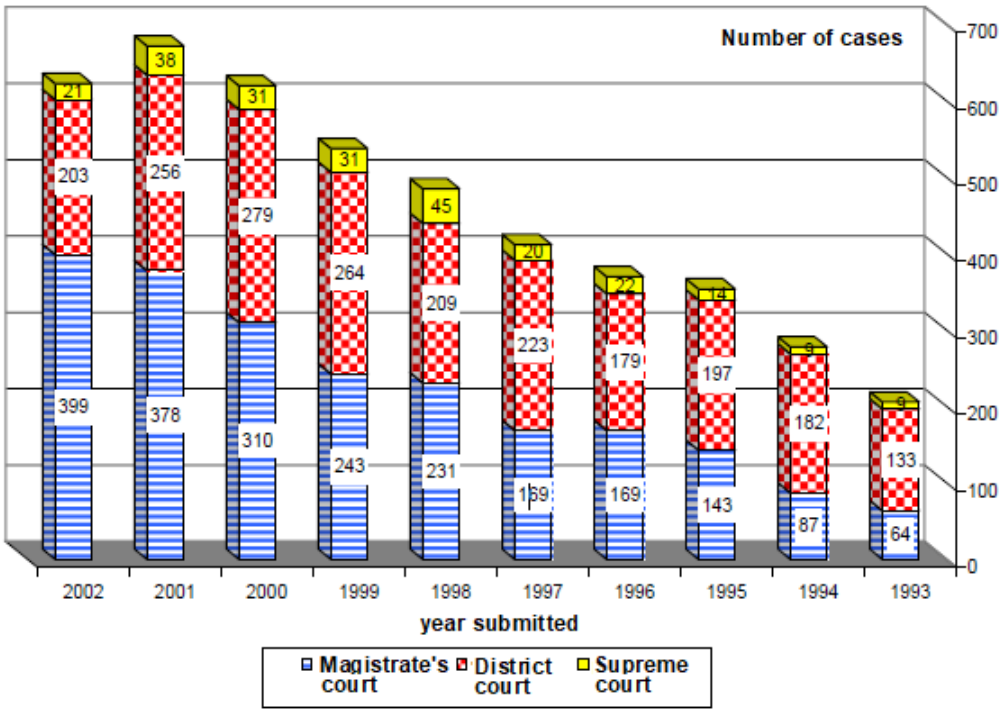

Figure 4.2: Number of cases by year submitted and by court in the years 1993-2002. Source: The report of the Tana Shpenitz committee for medical malpractice in Israel (2005), P.14, table 2.6

Figure 4.2 presents the number of lawsuits submitted in the years 1993-2002. Consistent with the anecdotal evidence, about 360 lawsuits were submitted to the magistrate's court per year during the period of 2000-2002, 9 times larger than the average number of investigation committees established in the MOH per year during the period of 2008-2016. Note that 360 is a lower bound to the number of lawsuits in the period of 2008-2016, because the number of lawsuits increases over time. This example illustrates that although government agencies are entitled to investigate medical malpractice, the courts may play a more crucial role in the pursuit of public health.

Potential sources for inefficiency

Concerns are often raised about the difficulties to detect malpractice behavior, specifically medical malpractice, because of structural and cultural reasons. For example, the Israeli Law of Patient's Rights (Paragraphs 21-22) has been criticized for providing full confidentiality to internal investigations and disciplinary committees in hospitals and to protocols of external investigation committees. Moreover, it has been argued by doctors and lawyers that there is a culture of cover-up of medical malpractice, sham peer review and retaliation against whistle-blowers in the name of professional ethics and loyalty to colleagues. Additionally, many malpractice lawsuits end up in settlements, and these settlements include a clause where patients commit to silence about the case.

Another potential reason for 'too-little-too-late' detection of malpractice may be the FDA reporting system in the US. While medical companies are supposedly obliged to report, their objectivity is questionable. They engage in lobbying their products and they finance most of the research (in the US they paid doctors more than 2 billion in 2016). Therefore, they naturally have incentives to be over optimistic about their findings (over-report positive findings and over-generalize them to population groups that have not been tested, and under-report risks and failures). The system then relies on the self-report of Doctors, which is, regrettably, voluntary.

Practically, this reporting system is argued to result in under-reporting of only 3-4% adverse effects and a time delay until complaints build-up. Moreover, as doctors and patients rely on this system, they potentially dismiss their own experience and crowd-out from reporting and pursuing lawsuits. These structural and cultural issues may pose difficulties to detect malpractice. We model them via the parameter of government efficiency.

Appendix B

```
                           regressions_high_low.txt
Low-efficiency (efficiency<=0.51)


      Source |       SS           df       MS      Number of obs   =        51
-------------+----------------------------------   F(2, 48)        =      0.04
       Model |  .035730329         2  .017865165   Prob > F        =    0.9594
    Residual |  20.6889607        48  .431020015   R-squared       =    0.0017
-------------+----------------------------------   Adj R-squared   =   -0.0399
       Total |   20.724691        50  .414493821   Root MSE        =    .65652

------------------------------------------------------------------------------
 lndeaths_per_P |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+-------------------------------------------------------------
     efficiency |    -.38786   1.512178    -0.26   0.799    -3.428298    2.652578
 GNI_per_capita |  -.0003054   .0032006    -0.10   0.924    -.0067406    .0061299
          _cons |   2.972716   .6446492     4.61   0.000     1.676562     4.26887
------------------------------------------------------------------------------


High-efficiency (efficiency>0.51)

      Source |       SS           df       MS      Number of obs   =        52
-------------+----------------------------------   F(2, 49)        =     11.50
       Model |  5.74227328         2  2.87113664   Prob > F        =    0.0001
    Residual |  12.2303008        49  .249597975   R-squared       =    0.3195
-------------+----------------------------------   Adj R-squared   =    0.2917
       Total |   17.972574        51  .352403412   Root MSE        =     .4996

------------------------------------------------------------------------------
 lndeaths_per_P |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
----------------+-------------------------------------------------------------
     efficiency |  -3.213928   .6803955    -4.72   0.000    -4.581234   -1.846622
 GNI_per_capita |   .0017085   .0025735     0.66   0.510    -.0034632    .0068801
          _cons |   4.272518   .4581484     9.33   0.000     3.351834    5.193201
------------------------------------------------------------------------------


                                    Page 1
```

Figure 4.3: regressions of road fatalities per 100,000 population (in log values) on government efficiency and GNI per capita for two sub-samples: countries above the median efficiency level ('high efficiency') and countries below the median ('low efficiency'). Source: Global status report on road safety 2015, World Health Organization; the World Justice Project (WJP) Rule of Law Index 2017-2018 report

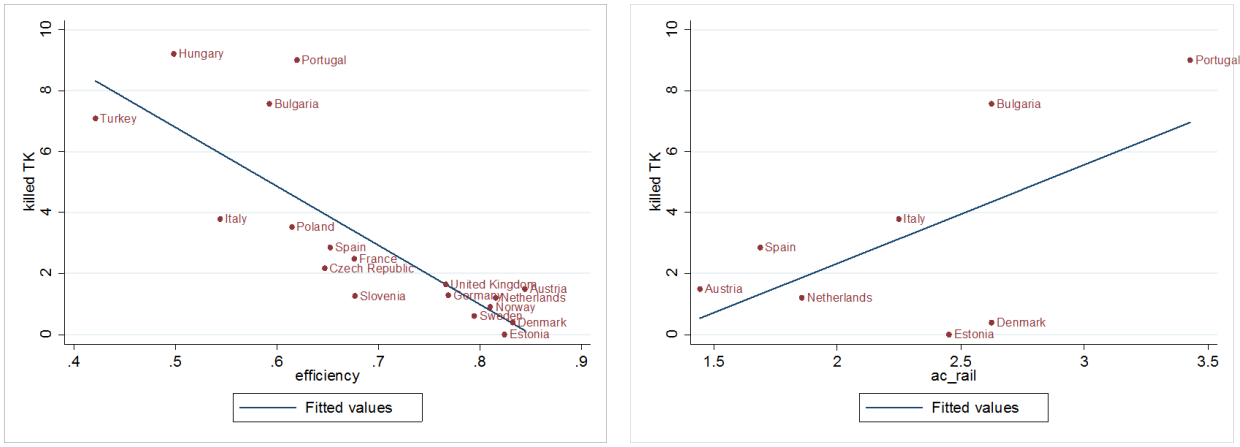

Figure 4.4: Victims in rail accidents per ton-kilometer VS government efficiency or government accountability (EU countries). Sources: Railway safety data collected by the European Union; The World Justice Project (WJP) Rule of Law Index 2017-2018 report, OECD indicators for management practice of sector inspectors. '0' is the largest accountability, '6' is the smallest. Figure 4.4 illustrates the positive relation across counties between railroad safety outcomes and government efficiency and accountability.

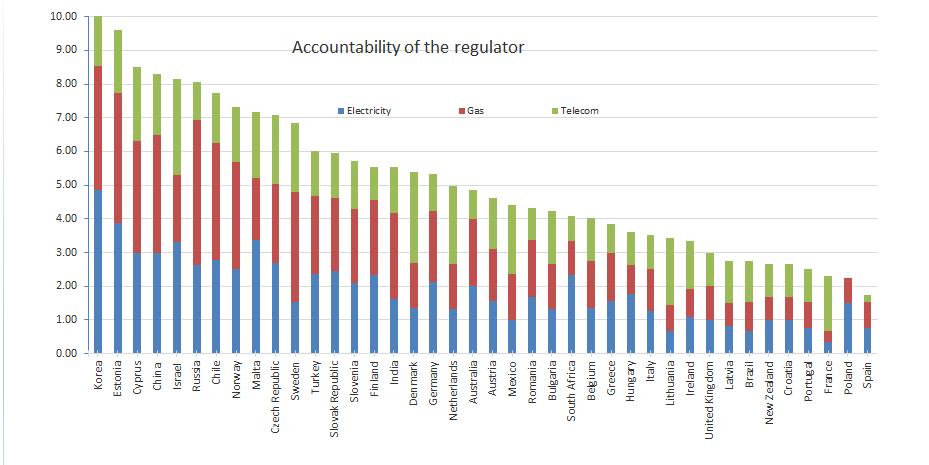

Figure 4.5: Government accountability. Source: OECD indicators for management practice of sector inspectors, '0' is the largest accountability, '6' is the smallest. Figure 4.5 presents the government accountability for three industries, electricity (in blue), gas (in red), and Telecom (in green), summed up for 40 countries. The figure illustrates the differences across sectors within countries and across countries. The summed-up value of all sectors ranges between a large accountability level of roughly '2-3' in several countries and a low accountability level of around '10' in Estonia and Korea.

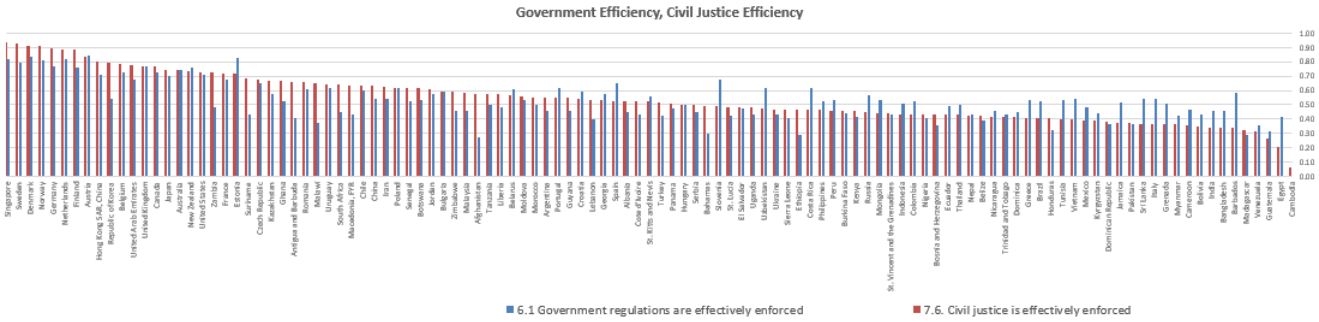

Figure 4.6: Government efficiency VS Civil Justice efficiency (113 countries). Source: The World Justice Project (WJP) Rule of Law Index 2017-2018 report

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	0.528126271	0.543782
Variance	0.018364879	0.027897
Observations	113	113
Pearson Correlation	0.744641629	
Hypothesized Mean Difference	0	
df	112	
t Stat	-1.485389416	
P(T<=t) one-tail	0.070125008	
t Critical one-tail	1.658572629	

Figure 4.7: Government efficiency VS Civil Justice efficiency (19 EU countries) . Source: The World Justice Project (WJP) Rule of Law Index 2017-2018 report

Appendix C: Proofs

Proof of Proposition 1. 1. Let $b < c$. Then (s) is a dominated strategy of C. Therefore, P chooses (ne) with certainty and obtains a payoff 1.

2. Let $b > c$. In this case, there is no equilibrium with pure strategies. If P chooses (e) with certainty, then (ns) is the best reply of C, but then P is better off by deviating to (ne). Similarly, it is easy to verify that pure (ne), (s) and (ns) are not possible in the equilibrium. In the unique equilibrium of Γ_1, P is indifferent between (e) and (ne), namely,

$$x = 1 - P_s,$$

equivalently,

$$P_s = 1 - x.$$

Let $P(ne|l)$ be the probability C assigns to the event "P chooses (ne)" if the quality of the product is low. Note that

$$P(ne|l) = \frac{1 - P_e}{P_e(1-\alpha) + 1 - P_e} = \frac{1 - P_e}{1 - \alpha P_e}.$$

Since in equilibrium C is indifferent between (s) and (ns),

$$bP(ne|l) - c = 0,$$

or,

$$P_e = \frac{b-c}{b-\alpha c}. \tag{6}$$

□

Proof of Proposition 2. P weakly prefers (e) iff $x \geq 1 - rP_i$, which is equivalent to

$$P_i \geq \frac{1-x}{r}.$$

Namely, P excels effort if the probability to detect malpractice is sufficiently high,

$$P_e(P_i) = \begin{cases} 1 & , P_i \geq \frac{1-x}{r} \\ 0 & , P_i < \frac{1-x}{r} \end{cases}. \tag{7}$$

To ensure the effort of the provider (pure (e)) with minimal inspection cost, the inspector R chooses $\frac{1-x}{r} = P_i < 1$ (which is feasible because the inspector is efficient).

The consumer C, decides not to sue (ns). For $b < c$ (the lawsuit cost exceeds the compensation), (s) is a dominated strategy of C, which ends the proof. For $c < b$, (ns) is the best reply for C, because P chooses (e) with certainty. R prefers to inspect for sufficiently low c_R.

Uniqueness follows from Proposition 8. □

Proof of Propositions 4 and 5. Let $P_i = 1$. Then, P is indifferent between (e) and (ne) iff

$$x = (1-r)(1-P_s),$$

or

$$P_s = \frac{1-r-x}{1-r},$$

and $0 < P_s$ because the inspector is inefficient. In this case, for $P_i < 1$, F strictly prefers (ne).

In order to define the incentive constraint of the consumer, let $P(ne|nbl)$ be the probability C assigns to the event "P chose (ne)" if the quality of the product is low and no information is provided by R to C (thus, C was not compensated, and not informed that no malpractice is found, and may have an incentive to sue).

$$P(ne|nbl) = \frac{(1-P_e(1))(1-r)}{P_e(1)(1-\alpha)(1-t)+(1-P_e(1))(1-r)}.$$

C is indifferent between (s) and (ns) iff

$$P(ne|nbl) = \frac{(1-P_e(1))(1-r)}{P_e(1)(1-\alpha)(1-t)+(1-P_e(1))(1-r)} = \frac{c}{b},$$

by rearranging terms we obtain

$$P_e(1) = \frac{(b-c)(1-r)}{(b-c)(1-r)+c(1-\alpha)(1-t)}. \tag{8}$$

By (8), $P_e(1) < \frac{b-c}{b-\alpha c}$ for $t < r$ and $P_e(1) > \frac{b-c}{b-\alpha c}$ for $r < t$. It is easy to verify that $EU_R > 0$ for $c_R < c_R^*$.

Uniqueness follows from Proposition 8. □

Proof of Proposition 6. The proof is similar to Proposition **??**. The customer's best reply is (ns) if the payoff from (ns) is larger than the payoff from (s):

$$0 \geq -c + bG(r \leq \max[1-x, \frac{c_R(1-\alpha)}{\alpha}(1-x)]),$$

and it holds for $G(r \leq \max[1-x, \frac{c_R(1-\alpha)}{\alpha}(1-x)]) < \frac{c}{b}$. □

Proof of Proposition 7. In case of a realization $r = r_{min}$, assuming that $P_i = 1$, the provider P is indifferent between (e) and (ne) if:

$$x = (1 - r_{min})(1 - P_s),$$

and by rearranging terms we obtain that

$$P_s = \frac{1 - r_{min} - x}{1 - r_{min}} < 1.$$

P_s is feasible because the inspector R is inefficient.

In case of realization of r_{max}, the provider P prefers (e) if

$$x \geq (1 - r_{max}P_i)(1 - P_s).$$

It is easy to verify that for realization of r_{max}, $P_e(P_i) = 1$ if $P_i \geq \frac{r_{min}}{r_{max}}$ and $P_e(P_i) = 0$, otherwise. Then, to induce the provider P to excel effort, in case of r_{max} the inspector R chooses

$$P_i = \frac{r_{min}}{r_{max}} < \frac{1-x}{r_{max}}.$$

$EU_R > 0$ for sufficient low c_R.

The consumer C is indifferent between (s) and (ns) if:

$$0 = -c + b\frac{(1-\theta)(1-r)(1-P_e^{r_{min}})}{((1-r)(1-P_e^{r_{min}}) + [\theta + (1-\theta)P_e^{r_{min}}](1-\alpha))},$$

equivalently,

$$P_e^{r_{min}} = \frac{(1-r_{min})(1-\theta)(b-c) - (1-\alpha)c\theta}{c(1-\alpha)(1-\theta) + (1-r_{min})(1-\theta)(b-c)},$$

where $P_e^{r_{min}}$ is the probability that P makes the effort given $r = r_{min}$. $P_e^{r_{min}} > 0$ for

sufficiently low θ.

□

Next we characterize equilibrium of Γ_2 for regions, others than in Proposition 2 and **??**. Let $c < b$.

Proposition 8. Let $c < b$.

1. Let $c_R > \max[\frac{\alpha}{1-\alpha}, \frac{\alpha r}{(1-\alpha)(1-x)}]$. Then in an equilibrium of Γ_2, R mixes between $P_i = 0$ and $P_i = \frac{\alpha}{(1-\alpha)c_R}$. In the former case P chooses pure (ne), in the latter case he chooses pure (e). C sues P with positive probability.

2. Let $t < 1$, $c_R^* < c_R < \frac{\alpha}{1-\alpha}$ and $r < 1 - x$. Then in the unique equilibrium of Γ_2, R mixes between $P_i = 0$ and $P_i = 1$. In the former case P chooses pure (ne), in the latter case he chooses (e) with a positive probability. C sues P with positive probability.

3. Let $t = 1$, $c_R < \frac{\alpha}{1-\alpha}$ and $r < 1 - x$. Then in the unique equilibrium of Γ_2, R chooses $P_i = 1$, P chooses pure (e) and C sues P with positive probability.

Proof. We start with following lemma.

Lemma 1. Let $c < b$. Then, in equilibrium of G_2:

1. no pure (ne) is chosen;

2. $0 < P_i < 1$ and $0 < P_e(P_i) < 1$ is not possible;

3. no pure $P_i = 0$ is chosen. In a mixed strategies equilibrium, if $P_i = 0$ is chosen with positive probability, P's best reply is pure (ne).

Proof. 1. Assume by contradiction that P chooses (ne) with certainty. Then, the best reply by C is $P_s = 1$, but then P is better off by deviating to (e). This is a contradiction to (ne) being an equilibrium strategy of P.

2. Suppose by contradiction that there is an equilibrium where $0 < P_i < 1$ and $0 < P_e(P_i) < 1$. Since R can guarantee payoff 0 by choosing $P_i = 0$, $EU_R \geq 0$. P is indifferent between (e) and (ne). In this case, for $P_i = P_i + \epsilon$, (ϵ sufficiently small), P strictly prefers (e), namely, $P_e(P_i + \epsilon) = 1$. Accordingly, R can improve its payoff by increasing the probability of inspection by ϵ, which in turn induces the provider to excel effort (e) with certainty,

$$\Delta EU_R = \alpha[1 - P_e(P_i)] - \epsilon c_R[(1-\alpha)(P_i + \epsilon) - (1 - \alpha P_e(P_i))P_i] \to \alpha(1 - P_e(P_i)) > 0.$$

This is a contradiction to P_i^* being an equilibrium strategy.

3. (a) In equilibrium, $P_i(0)$ cannot be higher than 0 and lower than 1. Assume by contrary that $0 < P_i(0) < 1$. Namely, P is indifferent between (ne) and (e). Then, similar to part 2, R can improve upon $P_i = \epsilon$, ϵ sufficiently small, contradiction.

   (b) If $P_e(0) = 1$, then P strictly prefers (e) for any $P_i \geq 0$. Then $P_s = 0$ is a best reply of C, but then $P_e(0) = 0$ is a best reply of P, contradiction.

   (c) Assume by contrary that R chooses pure $P_i = 0$. This is a subgame of Γ_2 equivalent to Γ_1, therefore, no pure $P_e(0)$ is chosen. Contradiction to (a).

□

By Lemma 1, only following strategy profiles can be considered in equilibrium: pure $0 < P_i < 1$ and $P_e(P_i) = 1$ (Proposition 2); pure $P_i = 1$ (Proposition **??** and part 3 of the current propoistion); mixed strategies equilibrium, where R chooses with a positive probability some $P_i > 0$, while P reacts with pure (e) (part 1 of the current proposition); and mixed strategies equilibrium, where R chooses $P_i = 1$ with a positive probability (part 2 of the current proposition).

1. Consider R mixes between $P_i = 0$ and some positive P_i^*. In the latter case $P_e(P_i^*) = 1$.

R is indifferent between these two strategies, namely,

$$\alpha - (1-\alpha)c_R P_i^* = 0,$$

equivalently,

$$P_i^* = \frac{\alpha}{(1-\alpha)c_R}.$$

This implies $c_R > \frac{\alpha}{(1-\alpha)}$.

P_i^* is the minimal probability for which P weakly prefers (e) , namely,

$$x = (1 - rP_i^*)(1 - P_s).$$

This implies

$$P_s = \frac{1 - rP_i^* - x}{1 - rP_i^*},$$

and $P_s > 0$ for $c_R > \frac{\alpha r}{(1-\alpha)(1-x)}$. Note, $\max[\frac{\alpha}{1-\alpha}, \frac{\alpha r}{(1-\alpha)(1-x)}] = \frac{\alpha}{1-\alpha}$ for $r < 1 - x$.

2. Consider R mixes between $P_i = 0$ and $P_i = 1$. R is indifferent between these two strategies, namely,

$$\alpha P_e^*(1) - (1 - \alpha P_e^*(1))c_R = 0,$$

equivalently,

$$P_e^*(1) = \frac{c_R}{\alpha(1 + c_R)}.$$

This implies $c_R < \frac{\alpha}{(1-\alpha)}$. Let y^* be a probability with wich R chooses $P_i = 1$. Following a damaged product and no information given by R, C is indifferent between suing and not suing for

$$y^* = \frac{b - c}{(b - c)[P_e^*(1) + 1 - rP_e^*(1)] + cP_e^*(1)(1 - \alpha)(1 - t).}$$

$0 < y^* < 1$ for $c_R > c_R^*$. Note, that for $t = 1$, $c_R^* = \frac{\alpha}{(1-\alpha)}$, namely, no c_R satisfies $c_R^* < c_R < \frac{\alpha}{1-\alpha}$.

$P_i = 1$ is the minimal probability for which P weakly prefers (e) , namely,

$$x = (1 - r)(1 - P_s).$$

This implies

$$P_s = \frac{1 - r - x}{1 - r},$$

and $P_s > 0$ for $r < 1 - x$.

3. $P_e(1) = 1$ and $P_i = 1$ implies that $P_i = 1$ is the minimal probability for which P weakly prefers (e). Thus,

$$x = (1 - r)(1 - P_s),$$

and

$$P_s = \frac{1 - r - x}{1 - r}.$$

$P_s > 0$ for $r < 1 - x$. Note, that the event "the quality of the product is low and no information is provided by R to C", where C chooses to sue or not, occurs with zero probability for $t = 1$ (that is the only case where (s) with positive probability is a best reply to $P_e(1) = 1$). For $P_e(1) = 1$, R weakly prefers $P_i = 1$ if

$$\alpha - c_R(1 - \alpha) \geq 0,$$

which holds for $c_R < \frac{\alpha}{1-\alpha}$.

□