The Economics of the Right to be Forgotten*

Byung-Cheol Kim† Jin Yeub Kim‡

June 13, 2015

Abstract

We study the underlying economics behind the burgeoning debate on the "right to be forgotten." One individual's right to privacy may collide with others' rights of free speech and access to information. We offer a model of the right to be forgotten as a legal dispute game between petitioner(s) and a search engine. Our equilibrium analysis implies that, as long as the claim fee is small enough, the petitioner with a certain level of harm from defamatory links will act aggressively to claim the removal and go to litigation if the claim is rejected. Surprisingly, we show that a higher loss from broken links decreases the expected number of broken links. In this sense, we argue that the global expansion of the European ruling is neither necessarily posing a threat to the freedom of speech, nor protect the privacy right of the European more effectively.

Keywords: privacy, right to be forgotten, reputation, litigation, search engine.

JEL Classification: C72, D82, K20, K41, L86.

---

*We are grateful to many for helpful comments and discussions, in particular, Jay Pil Choi, Jon Eguia, Thomas Jeitschko, Doh-Shin Jeon, David Laband, Qihong Liu, Arijit Mukherjee, Matthew Oliver, Eric Posner, Lars Stole, and the seminar attendants at the University of Memphis, Michigan State University, Georgia Tech, Sungkyunkwan University, and the 2015 Annual International Industrial Organization Conference.

†School of Economics, Georgia Institute of Technology, 221 Bobby Dodd Way, Atlanta, GA 30332-0615, E-mail: byung-cheol.kim@econ.gatech.edu, Webpage: `https://sites.google.com/site/byungcheolkim76`

‡Department of Economics, University of Nebraska-Lincoln, 1240 R Street, Lincoln, NE 68588, E-mail: shiningjin@gmail.com, Webpage: `https://sites.google.com/site/jinyeubkim`

1 Introduction

In 2009 Mario Costeja González, a Spanish lawyer, requested that Google Spain remove a link to a digitized 1998 article in *La Vanguardia* newspaper about the forced sale of his property arising from social security debts. His grounds were that the forced sale had been concluded years before, a debt had been paid in full, and information regarding his home-foreclosure notices was no longer relevant but defamatory. When the request was unsuccessful, Costeja sued Google, and the case was eventually elevated to the European Court of Justice (ECJ). In May 2014, the court found for Costeja and ordered both Google Inc. and its subsidiary Google Spain to remove the list of pertinent links from Google search results on Costeja's name.[1] The court further ruled that search engines with European domains such as Google, Bing, and Yahoo are obliged to remove, when requested by an individual, links to web pages that contain 'inadequate, irrelevant or no longer relevant, or excessive' information relating to that person in the search results. Upon the ruling Google launched the online request process on May 29, 2014 and has fulfilled about 41.3 percent of more than 262,000 link-removal requests that it has received over the year from individuals in EU and EFTA countries.[2] Table 1 shows data on total number of requests Google has received, total number of URLs that Google has reviewed for removal, and the percentages of URLs removed for the top five countries.

Despite Google's launch of the online request process in compliance to the European ruling, the scope of applying such rights have become extremely controversial.[3] Privacy watchdogs in the European Union have issued guidelines in September 2014 calling on Google to

[1]See "On being forgotten," *The Economist*, May 17, 2014. and Case C-131/12 *Google Spain SL, Google Inc. v Agencia Española de Protección de Datos, Mario Costeja González* [2014] ECLI:EU:C:2014:317.

[2]Microsoft and Yahoo also started to take the right to be forgotten requests to remove search results from Bing and Yahoo, respectively. (`http://www.theguardian.com/technology/2014/dec/01/microsoft-yahoo-right-to-be-forgotten`). The right to be forgotten is more broadly applicable to any data Internet operators not only limited to search engines. We will focus on Google as a representative player throughout this paper because Google's search market share in Europe was estimated more than 90% according to Stat Counter as of Oct. 2014 with Bing (2.67%), Yahoo (2.34%), and other (1.52%). (`http://www.businessinsider.com/heres-how-dominant-google-is-in-europe-2014-11`).

[3]See "A Question Over the Reach of Europe's 'Right to be Forgotten'," Mark Scott, *The New York Times*, Feb. 1, 2015, and "Europe's Expanding 'Right to Be Forgotten'," The Editorial Board, *The New York Times*, Feb. 4, 2015.

Table 1: European privacy requests for search removals on Google

Country	Total requests	Total URLs evaluated	% URLs removed
All EU and EFTA	**262,614**	**953,341**	**41.3**
France	53,950	181,368	47.8
Germany	44,447	169,461	48.7
U.K.	32,871	129,893	37.7
Spain	24,571	79,759	36.5
Italy	19,783	68,114	27.9

Source: `https://www.google.com/transparencyreport/removals/europeprivacy/`
(updated as of May 29, 2015, 3:30 pm EST)

apply the European ruling to its entire search engine. They argue that the local delisting is not effectually protecting the data subjects' rights because the EU law can be easily circumvented. However, Google restricted its compliance by removing the links from search results only in European versions of Google search services. This was because Google interpreted that the guidelines are not binding beyond the EU jurisdiction. In fact, Google's independent advisory council backed the company's practice that Europe's right to be forgotten is restricted only to the EU and EFTA.[4]

The controversy primarily stems from institutional and conceptual differences in how Europeans and Americans have perceived the related rights (See Ambrose and Ausloos (2013); Bennett (2012); Bernal (2014); McNealy (2012); Rosen (2012a,b); and Walker (2012)).[5] As Rosen (2012b) notes, the right to be forgotten in Europe finds its intellectual root in *le droit à l'oubli* in French law: a convicted criminal has a right to oppose the publication of his or her criminal history upon serving time. On the other hand, such right in the US would make conflicts with the First Amendment to the US Constitution that protects the freedom of speech. McNealy (2012) indicates that while some US plaintiffs have recently attempted to

[4]See, e.g., "Google Advisory Group Recommends Limiting 'Right to Be Forgotten' to EU," Alistair Barr and Sam Schechner, *The Wall Street Journal*, Feb. 6, 2015.

[5]This stark contrast stands out in the following case in point. Two Germans murdered a famous German actor Walter Sedlmayr and they served their time. Released from prison, they attempted to delete their names from the German Wikipedia article of the late Mr. Sedlmayr, which successfully led to the deletion. They further moved to scrub their names from the English-language version of the Wikipedia article by filing a suit against the Wikimedia Foundation, the non-profit American organization (located in San Francisco) that runs Wikipedia. However, the Foundation did not comply with the request obviously relying on the First Amendment; their names are still posted.See John Schwartz, *Two German Killers Demanding Anonymity Sue Wikipedia's Parent*, N.Y. TIMES, Nov. 12.2009.

assert a right to be forgotten through the US privacy law, the US court has seldom allowed for removing certain information from the press. Instead, such cases have been treated under the tort of invasion of privacy which may grant a recovery to an injured party from the public disclosure of private information.[6] In the meantime, according to a recent poll, fifty-two percent of US voters strongly supported to a law that would let them petition search engine companies such as Google, Yahoo, and Bing to remove certain personal information showing in search results.[7]

At the heart of this debate lie several conflicting interests. Individuals desire to avoid harms incurred by the search result links that are defamatory, embarrassing, or misleading. Therefore, the right to avoid the prominence of such information appears indispensable on the basis of privacy rights. However the removal of links under the pretext of protecting privacy rights can encroach other fundamental rights, such as the freedom of speech, expressions, and access to information, and generate various layers of social costs. For example, network users become deprived of the links that help them easily find content and they may demand the right to "remember." Also, missing information may generate social costs because reputation systems can be distorted when only bad reputations are diluted.[8] As a result, it is imperative to examine how the value of the right to be forgotten relative to the right to remember would influence individuals' behavior and search engines' response. In particular, we are interested in whether the expansion would increase the expected number of the right to be forgotten claims and when the expansion would be detrimental to social welfare. To the best of our knowledge, a formal economic analysis has yet been to answer these questions.

To address these questions, we set up an extensive-form legal dispute game between a petitioner and a web search engine in Section 2. The search engine has private information about her type, where the type is interpreted as the search engine's loss from the broken links. The petitioner, who suffers harm from the retained links, can request the removal via a costly process. The search engine can either accept or reject the claim. If the claim

[6]See Purtz v. Srinvisan, No. 10CESC02211 (Fresno Co. Small Cl. Ct. Jan. 11, 2011) in McNealy (2012). However, it is noteworthy that removing the links to the content from search results is different from removing the content itself; throughout this paper we focus on the former.

[7]See "Public wants 'right to be forgotten' online," Mario Trujillo, *The Hill*, Mar. 19, 2015.

[8] See "The Internet Memory Hole," Wendy Mcelroy, *The Freeman*, Nov. 24, 2014 .

is rejected, the petitioner can either give up or proceed to court against the search engine, where litigation is costly for both parties. The equilibrium of the game characterized in Section 3 predicts that, as long as the claim fee is sufficiently small, the petitioner will act aggressively and request the removal, in hopes of their request being accepted and, despite rejection, of having an option to proceed to litigation for potential win at court. Upon rejection, litigation always ensues if the petitioner's harm is large; otherwise litigation still arises with a positive probability. Given that the request process is easily accessible and that search engines would face costly litigation or sanction following their rejections, our model's predictions adequately describe the Europe's current situation over the right to be forgotten.

The basic setup of our game resonates with models in the literature on the economic analysis of litigation. For example, Bebchuk (1984) and Nalebuff (1987) model an extensive-form game of pretrial settlement negotiation between a plaintiff and a defendant in which the defendant has private information about his liability. Bebchuk (1984) focuses on how informational asymmetry influences the optimal settlement amount, and Nalebuff (1987) focuses on the role of credibility in this consideration by relaxing Bebchuk's assumption that the plaintiff's threat to litigate is always credible. Our model resembles that of Nalebuff (1987), but we address a different set of research questions. We focus on the effects of the relative size of social welfare loss from potential broken links on the players' decision-making. Therefore the likelihoods of lawsuits and broken-links and the expected number of claims in equilibrium in relation to the socially optimum amount are the objects of our interest.

In Section 4 we study how the ex ante probabilities of lawsuits and of broken links change in response to an increase in the network users' loss from broken links, denoted by S. We find that the probability of broken links unambiguously decreases with an increase in S because the search engine is less likely to accept under a higher S. Surprisingly, the probability of lawsuits increases in S up to a certain level of S. Although the petitioner would correctly expect to win a trial less often with the higher S, the search engine's rejection leads to litigation if the petitioner can commit to litigate with probability one upon rejection. If S is high enough, the search engine's rejection leads to a decrease in the probability of lawsuits because the petitioner starts to give up more often when the search engine rejects the request of the removal.

In Section 5 we compare our equilibrium with social optimum.[9] We study the condition under which too many links end up being deleted in equilibrium compared to the socially efficient level of deletion. We find that the expected number of broken links exceeds the socially optimal amount if the petitioner overestimates her winning probability at trial, which is more likely to occur when S is higher. Because the petitioner's lower expected probability of winning in court may not deter her from acting aggressively, we confirm one conspicuous concern in the debate that too many requests for the removal of links may be processed from a social welfare perspective.

Using our comparative static and efficiency results, we discuss the effects of the European ruling expansion to all of Google's global search engine domains in Section 6. Our key argument is that if the global expansion increases S and the court applies this change to its ruling, the amount of broken links would rather decrease because the search engines will decline the removal requests more often. We also find that the number of litigation can either increase or decrease under the global expansion, which depends on the level of S. Therefore, our analysis rather demonstrates that the expansion should not be taken as a threat to the right of free speech and access to information. Rather, the expansion should be applied and assessed in the perspective of an optimal balance between privacy and free speech. In this sense, our assertion sheds a new light on the debate of the global expansion of the right to be forgotten.

In Section 7 we explore possible extensions and other important implications regarding our modeling assumptions; and we conclude in Section 8. All proofs are in the appendix.

2 The Model

Two risk-neutral parties are involved in a potential legal conflict regarding the right to be forgotten, referred to as the *RTBF game*. A petitioner, often denoted as P, alleges that he suffers harm of size $h > 0$ from the links provided on a web search engine such as Google,

[9] In Section 5, we define the value of the right to be forgotten to be the (ex-post) social welfare loss from the links, measured by the petitioner's harm; and the value of the right to remember to be the (ex-post) social welfare loss from the broken links, measured by network uses' and search engine's loss. For our purpose, the definition of the right to remember subsumes both the right of free speech and access to information and the search engine's right to do business.

denoted as G.[10] G loses $L \geq 0$ if the links are removed; search engines may lose search efficiency due to the broken links and also need to build massive systems to handle removal demands. Even if G may not experience a direct monetary loss from the broken links, L can capture various costs associated with supporting the right to be forgotten going forward. The broken links may impose some more costs on the general public — in particular, network users. For example, some users may need to exert more effort (or may even fail) to find the exact content without the links offered by the search engine. To capture such externality, we denote by $S \geq 0$ total welfare loss to any party other than Google if the links are broken. S can be interpreted as the value of searched information to network users, or more broadly as the social value of the freedom of speech. It can also include social costs due to any bias to a reputation system from so-called 'Internet memory hole.'[11]

We assume that L is positively related to S because a larger loss to network users is likely to yield a higher loss to the search engine. In contrast, we imposes any deterministic relationship neither between h and S nor between h and L. The primary justification comes from the fact that the petitioner's harm mostly depends on his own individual characteristics. For example, Costeja might have relatively large harm than others in similar situations because as a lawyer he might lose some potential clients due to search results on his blemished reputation in the past. These assumptions substantially simplify the exposition while conveying all the key insights of our model.[12] Specifically let $L = \gamma S$, where $\gamma \in [0, \bar{\gamma}]$ possibly greater than one. So the total cost from the broken links is $L + S = (1 + \gamma)S$. Assume that h and S are common and public knowledge, whereas γ is G's private information.[13] P believes that γ is drawn from a non-degenerate distribution $F(\cdot)$ over the interval $[0, \bar{\gamma}]$.

The game tree illustrated in Figure 1 describes the sequence of events. P first chooses

[10]For exposition, we use male pronouns for the petitioner and female pronouns for Google. Again, we note that G can represent any data operator subject to the right to be forgotten ruling.

[11]We will elaborate on this kind of social costs in Subsection 7.4. See footnote 8.

[12]One may argue a potential positive correlation between h and S claiming that a petitioner's harm comes from users' search and the value of the right to remember increases ith the search intensity. Then we can write $h = \delta S$ with $\delta > 0$. Also, some may suggest that a petitioner's harm level is positively related to G's loss from the broken links, that is, a positive relationship between h and $L = \gamma S$. However our main results continue to hold whenever L remains private information to G.

[13]We discuss alternative information settings in Subsection 7.1.

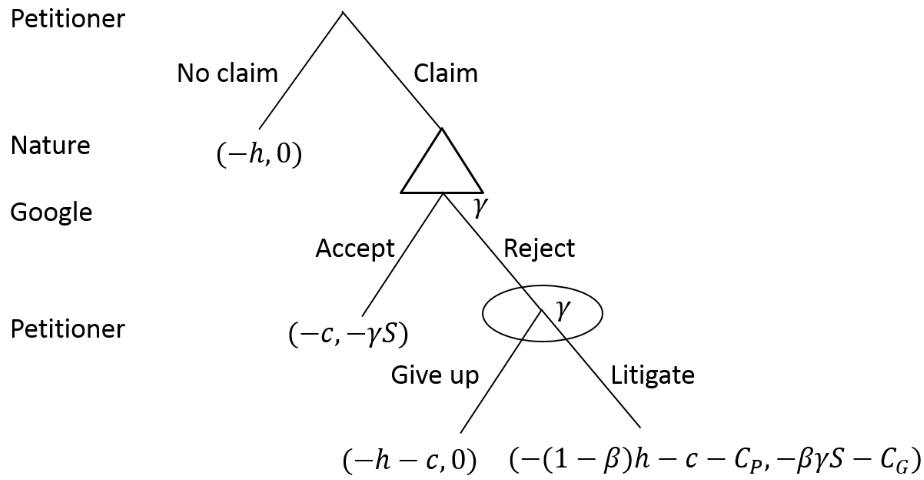


Figure 1: The game tree

either to "claim" (i.e., requests G to remove the links) at a fee of $c > 0$, or to make "no claim." This decision is made without knowing G's γ. Once a claim is filed, G then decides whether to accept or reject the claim. If G accepts and takes down the links, she loses γS and the petitioner receives payoff of $-c$. If G rejects, then the petitioner will have to choose whether to "litigate" or "give up" (i.e., drop the case), still not knowing G's γ. By giving up, P's payoff is $-h-c$ and G's payoff is zero. If P litigates and a trial takes place, then the litigation costs of P and G will be C_P and C_G, respectively. Let β be the likelihood of P's prevailing in a trial. Under the American rule on litigation fees, the expected payoffs from litigation then are $-(1-\beta)h - c - C_P$ for P and $-\beta\gamma S - C_G$ for G.[14]

The expected outcome of a trial depends on the factual issues relevant to the links in question, so the expected ruling of a trial can be estimated by h, γ, and S.[15] Thus we can assume that β is a function of the form:

$$\beta \equiv g(h, \gamma, S),$$

where g is a twice-differentiable function, $0 \leq g(h, \gamma, S) \leq 1$, and its partial derivatives

[14]We examine our game under the British rule of litigation fees and discuss relevant results in Subsection 7.2.

[15]How a function g behaves should be crucially affected by social norms of a given jurisdiction: β in Europe can be much higher than that in US, even for the same factual components.

satisfy $g_h \geq 0$, $g_\gamma \leq 0$, and $g_S \leq 0$ for all (h, γ, S). The conditions on the first derivatives assume that P's winning probability increases in his harm level saved by removing the links, but decreases in G's loss or the social costs to other network users.[16] Note that G's private information allows her to make a better assessment of the likelihood of the petitioner's prevailing in a trial (to be $g(h, \gamma, S)$); P does not know the exact value of γ, thus would form a posterior expectation of the winning probability $g(h, \gamma, S)$ given $F(\cdot)$. We further assume that $g_{\gamma\gamma}\gamma + 2g_\gamma < 0$ and $g + g_\gamma\gamma < 1$, $\forall\gamma \in [0, \bar{\gamma}]$. The first condition imposes upward concavity on G's expected payoff from litigation, ensuring that G's best responses are well defined; the second condition requires that the marginal value of switching from accepting to rejecting is monotone increasing in G's type γ, or requiring a strictly increasing differences property on G's expected payoffs.

While we describe the RTBF game as a dispute between a search engine and an individual petitioner with a fixed harm h, note that our model can be more flexibly interpreted. Suppose that the ECJ and Google both had correctly expected that many requests would follow up depending on which ruling is made for the Costeja case. Then, the court's decision rule β should be based on the *aggregate* values of the right to be forgotten and of the right to remember, beyond the Costeja case. In this sense, our model captures a class-action suit from a group of individuals against a search engine. Under this view, L would reflect Google's entire loss from all ensuing cases and S also measures the *aggregate* values of the right to remember. The court's ruling should also consider *aggregate* harms from all individual petitioners who are expected to consider to claim the right to be forgotten against a search engine.

Our game can be also useful to understand the current European situation after the Costeja's case: now any individual of twenty-eight EU member countries can make a request for search removals through a web-form in online request process launched by a search engine. For a submitted claim, the search engine evaluates whether the search results include

[16]For example, we can consider an explicit function of $g(h, \gamma, S) = \frac{h}{h+\gamma S+S}$. This functional form looks perhaps ad-hoc, but it can give us all explicit expressions for equilibrium results in primitives. Also, it well summarizes the essential component of the court's decision rule that depends on the relative balance between social welfare and loss that arise when one party wins. Online Appendix provides the equilibrium results under this function.

outdated or inaccurate information about the person, and weighs whether there is a public interest in the information remaining in the search results. When a search engine declines to remove certain information, an individual may request a data protection authority to review the search engine's decision. For example, the Information Commissioners' Office (ICO) in UK have handled over 183 complaints from the individuals disagreeing with Google's rejection. The ICO contended that Google had correctly rejected about three-quarters of them, but did not agree with Google's assessment in 48 cases and asked Google to revise her decisions.[17] Google may face some disciplines should it not accept the ICO's request for the revision. From this perspective, the 'litigation' in our model broadly subsumes a mechanism that determines the payoffs of a search engine and of the petitioiner when the petitioner does not give up after the initial rejection by the search engine.

3 Equilibrium Characterizations

In this section, we characterize conditions under which court-imposed settlements (or lawsuits) may arise as an equilibrium outcome, and analyze equilibria of this game. We find that as long as the claim fee is small enough, the petitioner with a certain harm from defamatory links will act aggressively and demand the removal, in hopes of his request being accepted and, despite rejection, of winning in court, both of which will lead to broken links.

Let P's strategy be represented by (p_1, p_2), where the first component indicates P's probability of requesting the removal; the second, his conditional probability of litigating if the claim is rejected. Let us consider the subgame following P's claim. In this continuation subgame, G with type γ compares her payoff from accepting, $-\gamma S$, with her expected payoff from rejecting, $(1-p_2)\cdot 0 + p_2\left[-g(h,\gamma,S)\gamma S - C_G\right]$, when she anticipated that the petitioner would behave according to p_2. Define γ_G to be the borderline type of G who is indifferent between accepting and rejecting the claim if G believes that the probability of P's litigation is p_2:

$$\gamma_G S = p_2\left[g(h,\gamma_G,S)\gamma_G S + C_G\right]. \tag{1}$$

Lemma 1. *There exists a unique $\gamma_G > 0$ that satisfies (1) given $p_2 > 0$.*

[17] See "Google in 'right to be forgotten' talks with regulator," Kevin Rawlinson, May 13, 2015 (available at `http://www.bbc.com/news/technology-32720944`).

Because the difference between G's expected payoff from rejecting and her payoff from accepting is a strictly increasing function of her type γ, no matter what P's action may be, G's higher types find rejection relatively more attractive than lower types do. Thus G will find it optimal to adopt a cutoff strategy.

Lemma 2. *Google's best response against any strategy of the petitioner, p_2, is using a cutoff strategy with the cutoff γ_G that is defined by (1), characterized as:*

(i) Types with $\gamma \geq \gamma_G$ reject the claim (assuming the indifferent type rejects);

(ii) Types with $\gamma < \gamma_G$ accept the claim.

Now the petitioner at his decision-node after the claim has been rejected must compare his payoff from giving up, $-h - c$, with that from litigation,

$$-\left(1 - g(h, \tilde{\gamma}(\gamma_G), S)S + S\right) h - c - C_P, \tag{2}$$

where P's posterior expectation of γ if the claim is rejected is given by

$$\tilde{\gamma}(\gamma_G) \equiv \mathbb{E}[\gamma|\text{"claim is rejected"}] = \mathbb{E}[\gamma|\gamma \geq \gamma_G] = \int_{\gamma_G}^{\bar{\gamma}} \frac{xf(x)}{1 - F(\gamma_G)} dx. \tag{3}$$

$\tilde{\gamma}(\gamma_G)$ is a monotonically increasing function of γ_G for any generic distribution F as long as it is non-atomic over the interval $[0, \bar{\gamma}]$. This is intuitive because when more types accept, the interval of types who reject decreases (i.e., γ_G rises up), and their expected γ increases. The higher posterior $\tilde{\gamma}$ in turn lowers P's expected winning probability at trial, and so the term (2) monotonically falls with γ_G.

The equilibrium characterization is of no interest if the petitioner will always give up upon rejection regardless of his posterior expectations or if G would always accept the claim no matter what her type is. Thus, we first assume that the petitioner's case has a merit as in Nalebuff (1987): litigation is better than giving up under the prior belief over G's loss.[18]

[18] Bebchuk (1984) assumes that litigation has a positive expected value for the plaintiff even if the defendant is of the lowest type. Translating into our model, this assumption is equivalent as to assume that litigation is profitable against G's highest type $\bar{\gamma}$. However, the litigation is not always credible and thus we make Assumption 1 which is a weaker version of Bebchuk's and equivalent to Nalebuff (1987)'s.

Assumption 1. $g(h, \mathbb{E}[\gamma], S)h > C_P$.

Assumption 1 requires that the petitioner will prefer litigation over giving up even if all types of G reject, so his posterior is identical to the prior. For Assumption 1 to be satisfied, P's harm should not be too small, nor its litigation cost should be too large; or the social value of the freedom of speech, captured by S, should not be too large in order for litigation to be ex-ante profitable to the petitioner. Even when a case has merit, P may not litigate with certainty. As more types accept, the petitioner lowers his posterior expectation of winning probability enough to opt for giving up.

Assumption 2. $(1 - g(h, 0, S))\bar{\gamma}S > C_G$.

Assumption 2 ensures that $\gamma_G < \bar{\gamma}$,[19] and implies some lower bound on S. This is intuitive because if S is too small, then rejecting (and subsequent litigation by P) will cause G to win litigation with a very small probability but with an additional litigation cost; therefore, any type of G may as well accept the claim. Similarly, G's litigation cost must not be too large. The above assumption also implies that P's harm should not be too large; if h is too large compared to S then even the highest type of G may not find it in her interest to reject the claim. Under Assumption 2, some types of G will always reject, i.e., $1 - F(\gamma_G) > 0$. Upon rejection, the petitioner forms his posterior expectation of γ given the posterior beliefs concentrated on $[\gamma_G, \bar{\gamma}]$, and decides whether to litigate or to give up. P's strategy p_2 must be optimal given G's optimal cut-off strategy γ_G. Let γ^* be the unique value that solves:

$$g(h, \mathbb{E}[\gamma|\gamma \geq \gamma^*], S)h = C_P, \tag{4}$$

that is, γ^* is the cutoff type of G that makes the petitioner indifferent between litigating and giving up upon rejection by those types above γ^*.[20] It trivially follows that $\gamma^* > 0$ from Assumption 1.

Lemma 3. *P's probability of litigation, p_2, must be a best response to G's optimal cut-off strategy characterized by γ_G:*

[19] In Appendix A, we derive this.

[20] Note that $\frac{\partial \gamma^*}{\partial h} > 0$, $\frac{\partial \gamma^*}{\partial S} < 0$, and $\frac{\partial \gamma^*}{\partial C_P} < 0$.

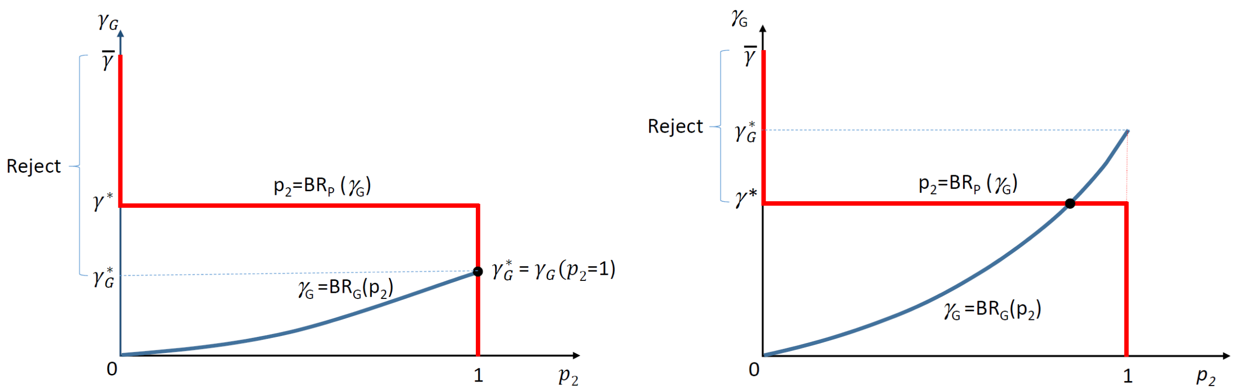
(i) Litigating is chosen over giving up: $p_2 = 1$ *if* $\gamma_G < \gamma^*$*;*

(ii) Litigating and giving up are indifferent: $p_2 \in [0, 1]$ *if* $\gamma_G = \gamma^*$*;*

(iii) Giving up is chosen over litigating: $p_2 = 0$ *if* $\gamma_G > \gamma^*$*.*

Define γ_G^* to be the cut-off type who is indifferent between accepting and rejecting the claim when G believes that P would litigate with certainty upon her rejection. That is, γ_G^* satisfies:

$$\gamma_G^* S = g(h, \gamma_G^*, S)\gamma_G^* S + C_G. \tag{5}$$



Case *(1)*: $\gamma_G^* < \gamma^*$ Case *(2)*: $\gamma_G^* \geq \gamma^*$

Figure 2: Best responses and Nash equilibrium in the continuation subgame of $p_1 = 1$

As Figure 2 illustrates, we have two different cases. If $\gamma_G^* < \gamma^*$, the two best responses meet at $p_2 = 1$. By contrast, if $\gamma_G^* \geq \gamma^*$, they meet at $p_2 < 1$ where the petitioner mixes over litigation with probability p_2 and giving up with $1 - p_2$, and p_2 is determined by (1). To understand more clearly why $p_2 < 1$ is the case when $\gamma_G^* \geq \gamma^*$, suppose that P were to commit to litigation with $p_2 = 1$ even when all the types with $\gamma \geq \gamma_G^*$ reject. Then, because P's litigation becomes unprofitable (Lemma 3-(iii) $\gamma_G(p_2 = 1) > \gamma^*$), his commitment to litigation is not credible. Rejection by less of high types provides more information that P's case is weak, which leads P to lower his probability of choosing "litigate" so as to make more types of G reject. His now-lower probability of litigating implies a greater chance of being rejected, but after rejection he was correct to litigate according to such probability, which confirms P's indifference between litigation and give-up.

We now characterize a unique equilibrium to the continuation subgame following P's claim.

Proposition 1. *Under Assumptions 1 and 2, there is a unique Nash equilibrium in the subgame when the claim is made, in which the equilibrium strategies are characterized as follows:*

(i) If $\gamma_G^* < \gamma^*$, then G of type $\gamma \geq \gamma_G^*$ reject the claim, G of type $\gamma < \gamma_G^*$ accept the claim, and P always choose to litigate, $p_2 = 1$;

(ii) If $\gamma_G^* \geq \gamma^*$, then G of type $\gamma \geq \gamma^*$ reject the claim, G of type $\gamma < \gamma^*$ accept the claim, and P chooses to litigate with probability $p_2 = \frac{\gamma^* S}{g(h,\gamma^*,S)\gamma^* S + C_G} \in (0, 1]$.

In addition, P's posterior beliefs satisfy Bayes' theorem upon rejection given the priors, i.e., $\frac{f(\gamma)}{1-F(\gamma_G)}$, where γ_G is the cutoff value of G's strategy.

The equilibrium strategies described above form the unique equilibrium in behavioral strategies. Under Assumption 2, the rejection state occurs with positive probability under the unique equilibrium, thus the equilibrium strategies are always sequentially rational for P upon rejection with the beliefs specified above.[21]

Consider now P's initial node in which he has to decide whether to claim or not. The petitioner's no claim payoff is $-h$. His expected payoff from claim is obtained under the prior distribution of Google's types given the equilibrium strategies specified in Proposition 1 as follows:

$$F(\gamma_G)(-c) + (1 - F(\gamma_G))\left[(1 - p_2)(-h - c) + p_2\left(-\left(1 - g(h, \tilde{\gamma}(\gamma_G), S)\right) h - c - C_p\right)\right]. \quad (6)$$

Then P's optimal strategy at his initial node would be to claim if the value in (6) is greater than or equal to $-h$. This condition reduces to

$$c \leq F(\gamma_G)h + (1 - F(\gamma_G))p_2\left[g(h, \tilde{\gamma}(\gamma_G), S)h - C_P\right]. \quad (7)$$

[21]The beliefs are weakly consistent with the equilibrium in behavioral strategies. Because $1 - F(\gamma_G) > 0$, rejection is never a zero-probability event and so weak sequential equilibrium implies full sequential equilibrium.

The right-hand side of (7) is P's expected benefit of making the claim. The petitioner can save his privacy harm without litigation with probability $F(\gamma_G)$ from G's acceptance. The petitioner faces the rejection with probability $1 - F(\gamma_G)$; then he litigate with probability p_2, and his winning probability at trial is $g(h, \tilde{\gamma}(\gamma_G), S)$ and the litigation cost is C_P. As is evident from (7), if the primitives of our model were such that $\gamma_G^* \geq \gamma^*$, then given the subgame equilibrium strategies specified in Proposition 1, (7) becomes

$$c \leq F(\gamma^*)h \tag{8}$$

because $[g(h, \tilde{\gamma}(\gamma_G), S)h - C_P] = 0$ and $\gamma_G = \gamma^*$.

If the primitives were such that $\gamma_G^* < \gamma^*$, then given the subgame equilibrium, (7) becomes

$$c \leq F(\gamma_G^*)h + (1 - F(\gamma_G^*))\,[g(h, \tilde{\gamma}(\gamma_G^*), S)h - C_P] \tag{9}$$

where we use $p_2 = 1$ and $\gamma_G = \gamma_G^*$. The intuition is straightforward: the claim fee has to be small enough for "claim" to be profitable to the petitioner assuming that all moves after the claim would be determined according the strategies specified in Proposition 1. Adopting the tie-breaking rule that the petitioner moves for the RTBF when (7) holds as equality, we can summarize thus far analysis as follows.

Proposition 2. *Under Assumptions 1 and 2, for any given c, h, S, C_P, and C_G, P's strategy p_1 such that $p_1 = 1$ if (7) holds and $p_1 = 0$ if otherwise, together with the strategies and beliefs described in Proposition 1, constitute a unique sequential equilibrium of the RTBF game.*

4 The Effects of Higher Users' Welfare Loss

In this section, we examine the effect of a change in users' welfare loss S on the *probability of lawsuits*, that is, the likelihood that the case will be settled in court once the claim has been made. We also calculate the *probability of broken-links* as a final outcome in equilibrium.[22]

[22] Another important factors that shape the probability of lawsuits and the probability of broken links are the magnitude of the parties' litigation costs. The comparative static results regarding the effects of higher C_G or C_P can be found in Subsection 7.3.

We find that the probability of broken links unambiguously decreases with an increase in S because G is less likely to accept with a higher S. On the other hand, the probability of lawsuits does not show a monotonic decrease with an increase in S. An intuition might suggest that if there is a higher welfare loss to users from the broken links relative to the petitioner's harm, then the petitioner should expect to lose the trial with a higher probability and so litigation becomes less likely. However we find that this is not necessarily the case. Intuitively, despite the facts that the search engine would reject more often and the petitioner correctly expects to win less often, more rejection will lead to more lawsuits upon rejection whenever the petitioner can commit to litigate with probability one.

Formally, the probability of lawsuits in the unique equilibrium of the subgame following the petitioner's claim is given by

$$Pr(\text{“lawsuits”}) \equiv (1 - F(\gamma_G))p_2 = \begin{cases} 1 - F(\gamma_G^*) & \text{if } \gamma_G^* < \gamma^*, \\ (1 - F(\gamma^*))\left(\dfrac{\gamma^* S}{g(h, \gamma^*, S)\gamma^* S + C_G}\right) & \text{if } \gamma_G^* \geq \gamma^*. \end{cases} \tag{10}$$

Note that the total prior probability that G will reject the claim is $1 - F(\gamma_G)$, where G's optimal cutoff value γ_G (either γ_G^* or γ^*) decreases in S. Hence, according to G's optimal cutoff strategy, $1 - F(\gamma_G)$ increases in S with a kink at $\gamma_G^* = \gamma^*$. Also notice that in equilibrium the probability that P litigates is $p_2 = 1$ when $\gamma_G^* < \gamma^*$, whereas p_2 decreases with S when $\gamma_G^* \geq \gamma^*$. Otherwise in the latter case, if P were to commit to litigation, then G with types $\gamma \geq \gamma_G^*$ will reject, in which case P's litigation becomes unprofitable and so his commitment to litigation is not credible. That is, rejection by less of high types provides more information that P's case is weak. Therefore P must lower his probability of choosing "litigate" so as to make more types of G reject. In particular, he would litigate with a lower probability just enough to make G of type $\gamma = \gamma^* \leq \gamma_G^*$ indifferent.[23] His now-lower probability of litigating implies a greater chance of being rejected, but after rejection he was correct to litigate according to such probability, which confirms P's indifference between

[23]This can be easily observed in Figure 2 Case *(2)* in Appendix A. As γ^* falls by an increase in S (the red horizontal line shifts down), then p_2 in Nash equilibrium, which is the fixed point of the best responses, decreases. Note that as S approaches $\bar{S}$, $\gamma^* \to 0$ and so $p_2 \to 0$.

litigation and give-up.

Define S^* to be the value of S such that $\gamma_G^* = \gamma^*$ given other primitives, and let $\bar{S}$ denote the upper bound of S implied by Assumption 1. Then, we find the probability of lawsuits achieves its maximum at a unique $\tilde{S} \in [S^*, \bar{S})$, which is illustrated in Figure 3 for a uniform distribution of γ.

Proposition 3. *For given h, C_P, and C_G, the probability of lawsuits increases with a small increase in S if $S < \tilde{S}$ but decreases with a small increase in S if $S \geq \tilde{S}$.*[24]

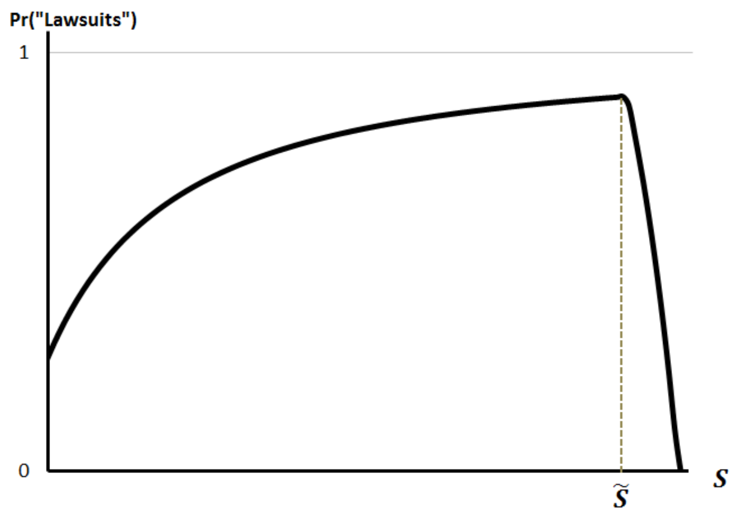


Figure 3: The effect of S on the probability of lawsuits in equilibrium

Let us give the intuition for Proposition 3 assuming $\tilde{S} = S^*$. When S increases, the probability of G's rejection increases and P's posterior assessed probability of winning in a trial decreases. This lowers P's expected payoff of the trial with his posterior concentrated on $[\gamma_G, \bar{\gamma}]$. When $S < S^*$, even though P's expected payoff from litigation falls by an increase in S, the increased S is not large enough to make litigation unprofitable compared to giving up. So, P can still litigate with probability one. Consequently, a higher S in this case has a correspondingly higher chance of being rejected by the search engine. On the other hand, if S increases when $S \geq S^*$, the increased probability of G's rejection makes P's litigation

[24]Under a certain condition on the right derivative of the probability of lawsuits evaluated at $S = S^*$, the maximum occurs at the kink $\gamma_G^* = \gamma^*$, that is, $\tilde{S} = S^*$. The condition is given in the proof of Proposition 3.

unprofitable compared to giving up. This implies that P would no longer be able to litigate with probability one; upon rejection, P would have to litigate less often to compensate for his loss from litigation. Such a fall in P's probability of litigation more than offsets the increased probability of rejection by G when $S \geq S^*$. Therefore, the overall probability of lawsuits fall.

We now assess the probability of broken links as a resulting equilibrium outcome. Our finding is summarized as follows:

Proposition 4. *The probability of broken links unambiguously decreases with an increase in S, for given h, C_P, and C_G.*

The links are removed in either of the following cases when the petitioner has made the claim: (i) G accepts the claim; or (ii) G rejects, the petitioner litigates and wins. Therefore, we can compute the expected probability of broken links:

$$\begin{aligned} &Pr(\text{“broken links”}) \equiv F(\gamma_G) + (1 - F(\gamma_G))p_2 g(h, \tilde{\gamma}(\gamma_G), S) \\ =&\begin{cases} F(\gamma_G^*) + (1 - F(\gamma_G^*))g(h, \tilde{\gamma}(\gamma_G^*), S) & \text{if } \gamma_G^* < \gamma^*, \\ F(\gamma^*) + (1 - F(\gamma^*))\left(\dfrac{\gamma^* S}{g(h, \gamma^*, S)\gamma^* S + C_G}\right) g(h, \tilde{\gamma}(\gamma^*), S) & \text{if } \gamma_G^* \geq \gamma^*. \end{cases} \end{aligned} \tag{11}$$

Let us decompose the two channels through which an increase in S separately affects the probability of broken links.

$$\underbrace{F(\gamma_G^*)}_{(1)} + \underbrace{(1 - F(\gamma_G^*))g(h, \tilde{\gamma}(\gamma_G^*), S)}_{(2)} \quad \text{if } \gamma_G^* < \gamma^*.$$

(1) As S increases, less types of G accept, that is, $F(\gamma_G^*)$ decreases, contributing to less chance of broken links;

(2) As more types of G reject but P's posterior expected probability of winning in court falls, so whether Term (2) rises or falls is ambiguous.

Regardless, the first effect is stronger than the second because P's expected winning probability is less than one, so that a decrease in Term (1) more than offsets any increase in Term

(2). Similarly for the second case, the decomposition yields the following two terms:

$$F(\gamma^*) + \underbrace{(1 - F(\gamma^*)) \left(\frac{\gamma^* S}{g(h, \gamma^*, S)\gamma^* S + C_G} \right)}_{=Pr(\text{“lawsuits”})} \underbrace{g(h, \tilde{\gamma}(\gamma^*), S)}_{(*)} \quad \text{if } \gamma_G^* \geq \gamma^*.$$

As is evident from the previous discussion, the first term $F(\gamma^*)$ decreases with S while $(1 - F(\gamma^*))$ increases. Even if $Pr(\text{“lawsuits”})$ may increase for $S \in [S^*, \tilde{S})$, the marginal increase is less than the marginal decrease in the first term. Moreover, the expected probability of P winning (Term (*)) is constant (and less than one) for any S. The reason is that when $\gamma_G^* \geq \gamma^*$, P is just indifferent between litigation and give-up after rejection by the types $\gamma \geq \gamma^*$, implying that his (posterior-assessed) probability of winning must remain the same regardless of a change in S.[25]

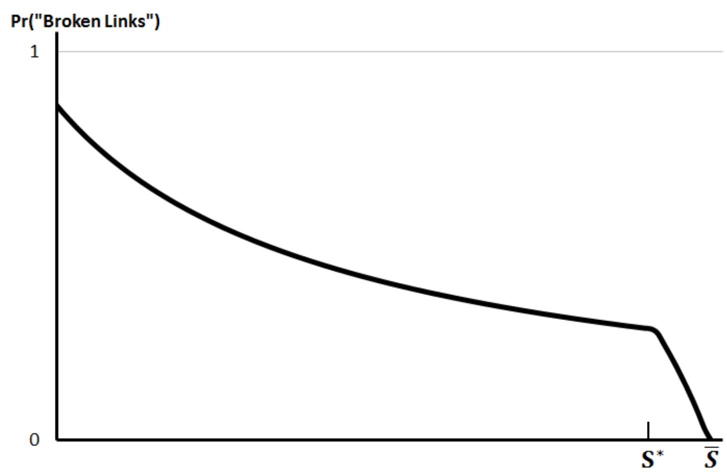


Figure 4: The effect of S on the probability of broken links in equilibrium

Regardless of whether $\gamma_G^* < \gamma^*$ or $\gamma_G^* \geq \gamma^*$, an increase in S unambiguously lowers the likelihood of broken links with a kink at $S = S^*$. If a higher welfare is lost from broken links, the court is more likely to rule in favor of G, which together with lower G's immediate acceptance of the claim primarily contribute to a lower chance of broken links. This effect is exacerbated when users' welfare loss is so high such that the petitioner starts to give up

[25]Given G's optimal cutoff strategy with the cutoff value γ^*, P's posterior expectation of γ on the interval $[\gamma^*, \bar{\gamma}]$ decreases as more types reject by an increase in S.

more often. Figure 4 drawn under a uniform distribution over γ illustrates these results.

5 Social Welfare and Efficiency

Using the preceding equilibrium analysis and comparative statics, here we study the conditions under which too many links end up being deleted under the RTBF regime. Furthermore, we examine when the number of removal requests exceeds the socially desirably level.

Consider a social planner whose objective is to maximize ex-post social welfare that amounts to total payoffs of petitioners, search engines, and network users less fixed costs. By ex post, we mean that claim fee and litigation costs are not included in the social planner's computation. This exclusion does not derive the result; rather, it obviates a trivial argument that social welfare is maximized under no claim equilibrium when fees are high enough. In our model the ex-post social welfare loss is given by $\gamma S + S$ if the links are removed and by h otherwise. Thus the social planner's decision would depend on whether h is higher than $\gamma S + S$ or not.

For any given h, γ, and S, if $h > \gamma S + S$, the *social efficiency* calls for the links to be delisted – "favoring" the right of privacy over the right of free speech, expression, and access to information; if otherwise, the links to be retained. We define this value as the social planner's *efficiency cutoff*, denoted by γ^e, such that:

$$\gamma^e = \begin{cases} \bar{\gamma} & \text{if } h \geq \bar{\gamma} S + S, \\ \frac{h-S}{S} & \text{if } S < h < \bar{\gamma} S + S, \\ 0 & \text{if } h \leq S. \end{cases} \tag{12}$$

Therefore, for given h and S, γ^e can be interpreted as the highest possible type of G against whom the social planner would dictate removal. Accordingly, the socially efficient probability of broken links is given by $Pr^e(\text{“broken links”}) \equiv F(\gamma^e)$.

Let $Pr^*(\text{“broken links”})$ denote the expected probability of broken links evaluated at equilibrium, given by (11). In principle, we can then say that whenever $Pr^*(\text{“broken links”}) < Pr^e(\text{“broken links”})$ too few links are expected to be broken in the equilibrium; otherwise, too many links are broken. In order to describe whether there are too many or too few links taken down in the equilibrium of our RTBF game, we adopt the following definitions. We will refer to an equilibrium in which the petitioner claims, i.e., c is such that (7) is satisfied, as a *claim* equilibrium. An equilibrium is a *no-claim* equilibrium if otherwise. In the claim equilibrium, the social planner's "assessment" of P's winning probability upon rejection by types $\gamma \geq \gamma_G$ can be defined as follows:

$$g^e(\gamma^e;\gamma_G) \equiv \begin{cases} \frac{F(\gamma^e)-F(\gamma_G)}{1-F(\gamma_G)} & \text{if } \gamma_G \leq \gamma^e, \\ 0 & \text{if } \gamma_G > \gamma^e. \end{cases} \tag{13}$$

If $\gamma_G > \gamma^e$, the social planner cannot find an excessive acceptance by any type of G, which implies that the social planner needs to assign zero winning probability of the petitioner for a given claim. However if $\gamma_G \leq \gamma^e$, those types with $\gamma \in [\gamma_G, \gamma^e]$ reject the claim in equilibrium although the social planner would have dictated the acceptance. We arrive at the following results.

Proposition 5. *For given h and S:*

(i) In the claim equilibrium,

$$Pr^e(\text{“}\textit{broken links}\text{”}) > Pr^*(\text{“}\textit{broken links}\text{”}) \quad \textit{if } g(h,\tilde{\gamma}(\gamma_G),S) < g^e(\gamma^e;\gamma_G);$$
$$Pr^e(\text{“}\textit{broken links}\text{”}) < Pr^*(\text{“}\textit{broken links}\text{”}) \quad \textit{if } g(h,\tilde{\gamma}(\gamma_G),S) > g^e(\gamma^e;\gamma_G).$$

(ii) In the no-claim equilibrium,

$$Pr^e(\text{“}\textit{broken links}\text{”}) > Pr^*(\text{“}\textit{broken links}\text{”}) = 0 \quad \textit{if } h > S;$$
$$Pr^e(\text{“}\textit{broken links}\text{”}) = Pr^*(\text{“}\textit{broken links}\text{”}) = 0 \quad \textit{if } h < S.$$

Proposition 5*(i)* implies that too few (many) broken links are expected to arise in the claim equilibrium if the petitioner underestimates (overestimates) the his winning probability in court.[26] When $g(h,\tilde{\gamma}(\gamma_G),S) = g^e(\gamma^e;\gamma_G)$, the expected probability of broken links in

[26] In other words, too few (many) broken links arise in the claim equilibrium if P's posterior expectation of γ upon rejection is less (greater) than the highest possible type against whom the social planner would dictate removal.

equilibrium exactly coincides with the socially efficient probability of broken links because the petitioner "correctly" updates his belief on the types of G who would reject, against whom the social planner would dictate removal. In such case, the amount of broken links in the claim equilibrium achieves social efficiency.

For the no-claim equilibrium, it is somewhat more obvious: If P's harm is greater than network users' welfare loss, then (12) implies that the social planner would find at least some (lower) types of G who should be dictated to remove the links but against whom the petitioner had not filed the claim in the first place. On the other hand, if otherwise, the social planner would prefer retention of the links even against a type of G who loses nothing, and so the no-claim equilibrium coincides with what social efficiency would dictate.

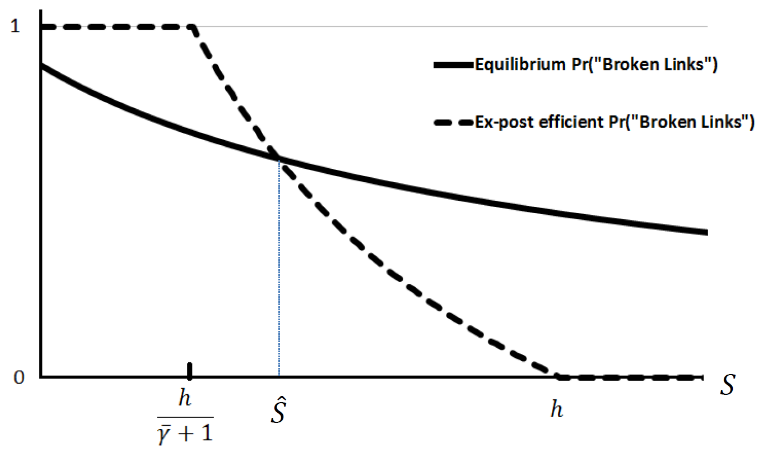


Figure 5: Equilibrium vs. optimal probability of broken links

Figure 5 illustrates Proposition 5*(i)* for given h in terms of S. The case of too few broken links occurs when S is relatively small; the opposite happens for a relatively larger S.

Beyond theoretical underpinning, Proposition 5 suggests a testable empirical study with data. Suppose that all factual information on the true values of h, γ, and S are available as well as the result of every case. Then we may possibly establish the efficient ruling for each case and compare it with its actual outcome, which can be essentially categorized into one of the following two cases: (i) the links remain uncut when they should have been removed from a social efficiency perspective; or (ii) the links are taken down when they should have been retained. If the first cases occur far more than the second, then the right to be forgotten is under-protected relative to the efficient level. On the other hand, if the second cases prevail, the right to be forgotten is threatening the right to remember beyond the properly balanced level.

As implied by Proposition 2, the petitioner tends to act aggressively and file the request for removal as long as his claim fee is small. Therefore one might reasonably expect to see too many claims compared to the social optimum for some range of values. We start by the following proposition.

Proposition 6. *For given h and S, if $\gamma^e < \bar{\gamma}$, then any claim equilibrium renders an excessive number of claims that are brought to a trial. Moreover if $\gamma^e < \gamma_G$, then the claim equilibrium renders an excessive number of claims that are accepted by G, as well as those that are brought to a trial.*

The condition $\gamma^e < \bar{\gamma}$ implies that $\gamma S + S > h$ for all $\gamma \in (\gamma^e, \bar{\gamma}]$. So if the social planner, who finds out that G is of such type in the RTBF game, would dictate the petitioner with harm h not to request the removal in the first place so that the links are not removed. In this sense, too many requests for the removal of links are brought to court and resolved by costly court-imposed judgments. The condition $\gamma^e < \gamma_G$ implies that there exists $\gamma \in (\gamma^e, \gamma_G)$ such that $\gamma S + S > h$. So if P's claim is submitted to such type, social efficiency calls for the claim not to be accepted immediately. In fact, the claims that are made to and accepted by Google of types $\gamma \in (\gamma^e, \gamma_G)$ and the ones that are rejected by G of types $\gamma \in [\gamma_G, \bar{\gamma}]$ should not have been in place.

On the other hand, if $\gamma^e = \bar{\gamma}$, i.e., the efficiency cutoff is exactly the highest G's type, then $h \geq \gamma S + S$ for any $\gamma \in [0, \bar{\gamma}]$. In such case, the petitioner was correct to file a claim in the sense that the social planner would prefer the petitioner to claim versus no-claim against any type of G.

Proposition 6 is illustrated in Figure 6, which plots the social planner's efficiency cutoff and G's optimal cutoff value of her equilibrium strategy in relation to S. The shaded area above the efficiency cutoff indicates the types of G against whom social efficiency would require the links to be retained for given h and S. Therefore the social planner, who finds out that G is of type $\gamma > \gamma^e$, would dictate the petitioner with harm h not to file a claim

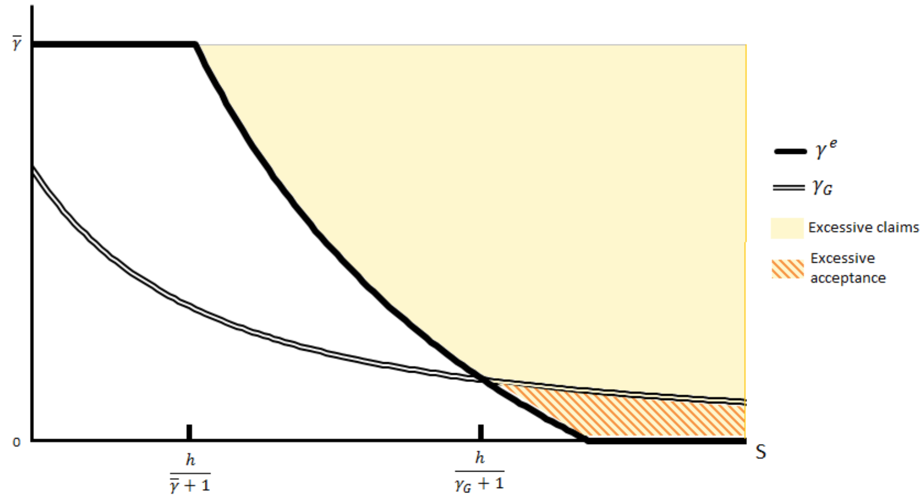


Figure 6: Excessive amount of claims

in the first place (or more generally retention of the links). Too many claims are filed and eventually brought to costly litigation when $S > \frac{h}{\bar{\gamma}+1}$; too many claims are accepted by G when $S > \frac{h}{\gamma_G+1}$.

6 The Global Expansion of the Right to be Forgotten

Privacy watchdogs in the European Union have called on Google to apply the European ruling to its global search results, claiming that local deletion is not effectively protecting the data subjects' rights due to the possibility of easy circumvention. Google's advisory council interpreted that the guidelines are not binding beyond the EU jurisdiction. Thus Google's compliance of the European ruling has been limited only to the European versions of Google search services. As a result, Google's evaluations of the removal requests depend on its assessment over the requester's harm and network users' welfare loss pertaining only to the *local* domain. We examine the following questions: What would be the effect of the expansion of the European ruling to all of Google's global search engine domains? Would the expansion of the right to be forgotten to non-European websites be a threat to the right to privacy? We use our preceding analyses in Sections 4 and 5 to offer our answers to these questions.

Note that if the deletion is applied in a far broader manner, then the network users' welfare loss from the broken links would be larger. In this sense, our key presumption is that the global expansion can be interpreted as an increase in S. We further assume that the size of the petitioner's harm h remains constant under the expansion. This is because for example Costeja's harm is mostly likely to occur from local searches; little is additionally to be saved by delisting his defamatory links from non-European domains. Alternatively, since other search engines than Google are easily accessible, we suspect that the global expansion would increase the amount of a petitioner's harm effectively. The relative value of the right to be forgotten would then lessen and the court — if the greater relative value of the right to remember is taken into account its ruling — would be more likely to favor the search engine. Taking these considerations into account, Propositions 3 and 4 directly imply the following argument.

Corollary 1. *Suppose that S is higher under the global expansion than Google's local compliance for a given h. Then:*

(i) The global expansion would contribute to fewer number of broken links.

(ii) The probability of lawsuits can either increase or decrease under the expansion regime.

Our discussion of efficiency in Section 5 renders a surprising policy implication on how to deal with the expansion. Suppose that the current ruling is not strong enough to protect the right to be forgotten and too many defamatory links remain uncut. If this is a case, the expansion will be hardly justified as an effort to strengthen the privacy protection as argued by some European data regulators, because the expansion would make more links uncut and make the welfare departing further from the social optimum. In contrast, if too many links are taken down under the current legal standard, the expansion may help to get close to the efficient outcome. Therefore, we find that the global expansion itself is not necessarily posing a threat to free speech; the expansion does not necessarily make better social and/or individual outcomes. Rather, our analysis demonstrates the expansion should be seen from the perspective of an optimal balance between privacy and free speech, which in our opinion sheds a new light on the debate of the global expansion.

Lastly, assuming that a petitioner's harm h goes up under the expansion will add more delicacy to thus far discussion. Now that the larger h under the global RTBF is going to make the court rule more in favor of the petitioner (other things being equal), the effects of the expansion would crucially depend on the relative magnitude of the changes in h and S owing to the expansion. Needless to say, if the overall assessment still tilts toward Google under the expansion, the messages derived from Corollary 1 remain intact qualitatively.

7 Discussions

7.1 Alternative Information Structures

Our RTBF game adopts a particular information structure that the petitioner's harm h is known to all, but search engine's γ remains private information. Thus, we find it worthwhile discussing other equilibria under alternative information structures.

Suppose both players have complete information about h and γ. In this complete information game, there arise two kinds of subgame-perfect equilibria. In one kind, the search engine is expected to accept the petitioner's claim, whereby the petitioner makes the claim if the claim fee is small. In the other kind, the search engine is expected to reject and the petitioner claims only when he credibly litigates. If so, however, the petitioner's claim becomes a mere cost with no benefit: why should a petitioner spend the claim fee despite that he already knows that Google's rejection and his litigation are sequentially rational as mutual best responses? This complete information benchmark, though it is furtherest from reality, is useful to make it clear what incomplete information would add to the analysis.

Consider now a situation in which h is private information, distributed over an interval $[\underline{h}, \overline{h}]$, and the search engine's type γ is public information. Then, we can derive three different kinds of equilibria: (i) the petitioner always chooses no claim for a sufficiently small h; (ii) the petitioner always claims and the search engine accepts for a sufficiently large h; and (iii) the petitioner with an intermediate h claims and goes to trial following the search engine's rejection. The first two cases (i) and (ii) are trivial, and for the last case (iii) we face the same problem that the petitioner *claims expecting rejection*. Investigating the first two alternative information structures, we realize that Google's private information is critical for reasonable theoretical underpinnings. Consequently, we had two choices left: one is to examine a game of two-sided private information, and the other is our RTBF game.

For the two-sided private information game, we need to consider Google's inference problem regarding the petitioner's harm level. As usual, then, the petitioner may have *signaling* incentives about his harm level by making the claiming. The extent of signaling incentives will be greater for the higher claim fee, c. But, c is expected to be small given that the process of claiming the right to be forgotten is quite simple. Thus, this two-sided private information is an interesting theoretical subject,[27] but the eventual equilibrium will be similarly characterized by Propositions 1 and 2. Furthermore, the petitioners' signaling about private harms appears not an issue of significance in the ongoing debate, as Google does not make settlements with individual petitioners. Since we do not lose any important economics by assuming away Google's uncertainty about the petitioner's harm, we espouse the simplified one-sided asymmetric information version for our primary model in which the petitioner's uncertainty about Google's potential response plays an essential role. In addition, our information structure is consistent with the models of Bebchuk (1984) and of Nalebuff (1987) that the defendant has private information, which reflects a tort suit case in which the defendant knows better about her negligence. Another advantage of our setup is its consistency with the current U.S. treatment of a privacy invasion incident under the tort law.

7.2 Different Legal Rules on Litigation Costs

We offered the analysis of the RTBF game based on the *American rule* of litigation costs that each party bears his or her own litigation costs regardless of the trial's outcome. Alternatively, we could offer the analysis with the payoffs governed by the *British rule* under which a losing party bears all litigation costs.

First, we notice that larger payoffs are affected by the court ruling under the British rule than under the American rule. Specifically, the below table shows the petitioner's payoff for each possible litigation outcome in the two fee regimes:

[27]For a comprehensive survey on settlement-litigation games with various information settings, see Daughety and Reinganum (2014).

P's payoff	Under American rule	Under British rule
Win at trial (β)	$-c - C_P$	$-c$
Loss at trial ($1-\beta$)	$-h - c - C_P$	$-h - c - C_G - C_P$
Expected	$-(1-\beta)h - c - C_P$	$-(1-\beta)(h + C_P + C_G) - c$

The petitioner's marginal benefit from litigating against the lower type of G is greater under the British rule than under the American rule. In addition, the amount that depends on the court ruling is greater under the British rule because the petitioner's litigation cost C_P under the American rule incurs regardless of a trial's outcome, whereas under the British rule the petitioner bears no litigation cost if he wins but $(C_P + C_G)$ if he loses. For the petitioner's best response, this means that a change to the British rule lowers the petitioner's optimal cutoff type of G, γ^*, that makes him indifferent between going to trial and giving up upon rejection.

How would the British rule affect Google? We find G's cutoff value γ_G of her equilibrium strategy may rise or fall depending on the litigation costs. To understand this result, note that G's expected payoff from litigation also depends on the petitioner's litigation cost C_P under the British rule because C_P becomes Google's burden when she loses the trial. Under the British rule G will suffer a loss of $\gamma S + C_G + C_P$ if she loses and will bear no loss if she wins, whereas under the American rule she will suffer a loss of $\gamma S + C_G$ if she loses and need to pay C_G even if she wins. Again, we summarize these payoff changes below.

G's payoff	Under American rule	Under British rule
Win at trial ($1-\beta$)	$-C_G$	0
Loss at trial (β)	$-\gamma S - C_G$	$-\gamma S - C_G - C_P$
Expected	$-\beta\gamma S - C_G$	$-\beta(\gamma S + C_G + C_P)$

Let γ_G^A (γ_G^B) denote the cutoff types who are indifferent between accepting and rejecting under the American (respectively, British) rule. Then, we find the relative sizes of γ_G^A and γ_G^B crucially depend on the relative magnitude of C_G and C_P. If C_P is sufficiently high such that G earns a higher litigation payoff under the American rule than under the British rule, the cutoff type γ_G^A who was indifferent between accepting and rejecting the claim under the American rule would find it strictly better to accept under the British rule. By contrast, if C_P is small enough, more types of G would reject under the British rule than under the American rule. In this regard, the "chilling effect" can be more serious concern under the British rule when each individual's litigation cost is high enough. Therefore the change from the American rule to the British rule generates an ambiguous effect on G's best response to a given claim under the same primitives.

Proposition 7. *A change from the American rule to the British rule might increase, decrease, or has no effect on the probability of lawsuits and the probability of broken links, depending on the primitives of the model.*

Even so, we note that Proposition 2 holds regardless of legal rules and all key insights of our analysis remain intact from any change in fee arrangements.

7.3 Higher Litigation Costs, Lawsuits, and Broken Links

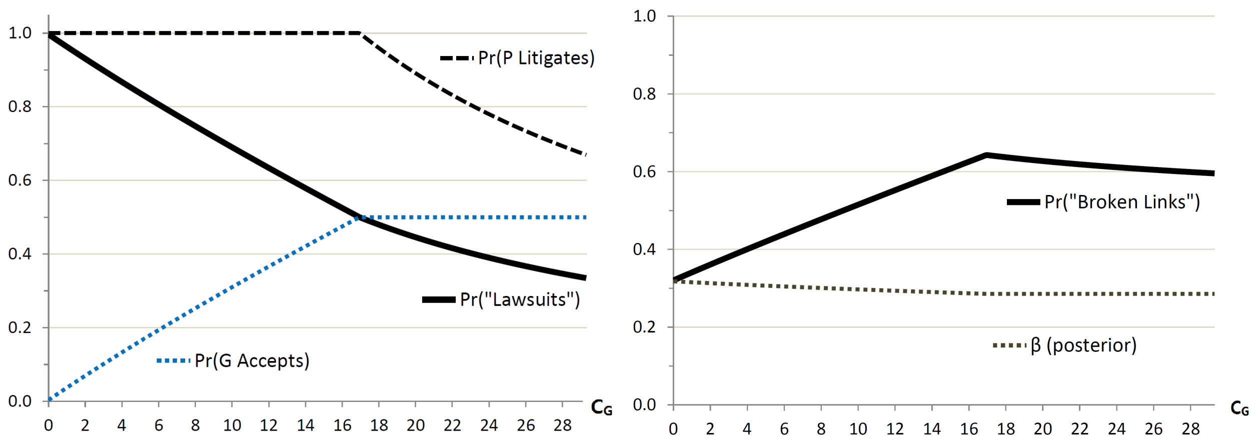
Because our RTBF game is featured as a legal dispute, the decision of G's rejection and P's litigation is shaped by various factors including litigation costs. As a complementary analysis to Section 4, let us discuss the effect of changes in litigation costs on the probability of lawsuits and the probability of broken links in equilibrium.

Note that Assumptions 1 and 2 requires certain upperbounds for C_P and C_G, respectively. Let $\bar{C}_P$ and $\bar{C}_G$ denote the corresponding upper-bounds, for given values of h and $S$and let C_P^* and C_G^* denote the values of C_P and C_G such that γ_G^* equals γ^*. Because $C_P \in (0, \bar{C}_P)$ and $C_G \in (0, \bar{C}_G)$, the subsequent results will hold for marginal changes in the parameters within the relevant range. Recall first that the probability of lawsuits and the probability of broken links are respectively given by (10) and (11), and that they have kinks at $\gamma_G^* = \gamma^*$. Also, it is useful to know how the best responses vary with litigation costs:

Lemma 4. *An increase in P's litigation cost, C_P, has no effect on γ_G^* but decreases γ^*. An increase in Google's litigation cost, C_G, increases γ_G^*, but has no effect on γ^*. Formally, it follows that*

$$\frac{d\gamma_G^*}{dC_P} = 0, \qquad \frac{d\gamma^*}{dC_P} < 0; \qquad \frac{d\gamma_G^*}{dC_G} > 0, \qquad \frac{d\gamma^*}{dC_G} = 0.$$

First, we find the conventional result that the probability of lawsuits falls as G's litigation



(a) Probability of lawsuits

(b) Probability of broken links

Figure 7: Comparative statics of C_G

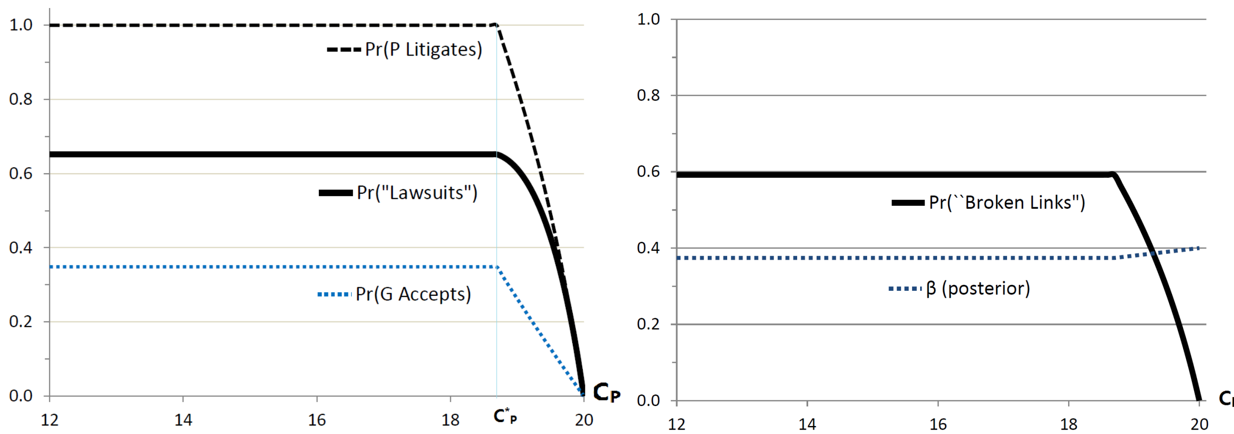
cost increases.[28] This is straightforward because, for any type, G's expected payoff from litigation becomes smaller with a higher litigation cost. A rather interesting observation is that an increase in G's litigation cost (up to a certain point) causes G more likely to accept P's claim, creating more chance of broken links despite a relatively low petitioner's winning probability. An increased acceptance by G makes P's inference about the case less favorable to him upon rejection; however the former direct effect dominates the latter indirect one. By contrast, when G's cost is sufficiently high, this result is reversed. An increase in C_G leads P to choose litigation with a lower probability, which induces exactly the same interval of G's types who would reject; but now that P chooses litigation with less probability, there is less chance of broken links.

Proposition 8. *The probability of lawsuits decrease in C_G for any $C_G \in (0, \bar{C}_G)$. The likelihood of broken links increases in C_G if $C_G \in (0, C_G^*)$, but decreases in C_G if $C_G \in [C_G^*, \bar{C}_G)$.*

As an illustrative numerical example, Figure 7 shows Proposition 8 for fixed values of $h = 35$, $S = 50$, and $C_P = 10$ with a uniform $F(\cdot)$ on $[0, 1]$ with $\beta = \frac{h}{h+\gamma S+S}$.

Now one might expect that when the petitioner would proceed to court less often for a

[28]Bebchuk (1984) shows that "an increase in the litigation costs of *either* party will increase the likelihood of a settlement" (p.409). The counterpart of the likelihood of a settlement translated into our setting is $1 - Pr$("lawsuits").



(a) Probability of lawsuits

(b) Likelihood of broken links

Figure 8: Comparative statics of C_P

higher own litigation cost, which would lead to less broken links. However, we show this is not always correct. A change in P's litigation costs has no effect on Google's cutoff type (Lemma 4), and so on the probabilities of acceptance and rejection, up to a large amount of C_P. Consequently, the expected number of lawsuits and the chance of broken links may remain constant. The intuition is that the types of G who reject are large enough ($\gamma_G^* < \gamma^*$) — enough to compensate for the petitioner's higher cost — that the petitioner believes that he still has a fair chance of winning in court and litigates with probability one. However, when the petitioner's litigation cost is too high, the petitioner must proceed to court less often to induce more types of G to reject. Less types of G accept and those types who reject are faced with much less probability of the petitioner's litigation, both of which lead to a decrease in the likelihood of broken links.

Proposition 9. *The probability of lawsuits and the likelihood of broken links both are not affected by a change in C_P if $C_P \in (0, C_P^*)$. However, both decrease in C_P if $C \in [C_P^*, \bar{C}_P)$.*

Figure 8 illustrates the effect of an increase in C_P for fixed values of $h = 50$, $S = 50$, and $C_G = 10$ with a uniform $F(\cdot)$ on $[0, 1]$ with $\beta = \frac{h}{h+\gamma S+S}$. We can easily see that a small increase in P's court cost leads to the same probability of lawsuits before it hits the threshold $C_P = C_P^* \approx 18.7$, then it starts to decrease for $C_P \in [C_P^*, \bar{C}_P)$ where $\bar{C}_P = 20$. The same pattern is confirmed for the likelihood of the broken links.

7.4 Threats to Reputation Capital

When an individual's dignity gets continuously tarnished from damaging reputation associated with past wrongful behaviors, it may be a respectable social value to offer a "reset" or "clean slate" over an individual's inimical reputation. From this perspective, the right to be forgotten laws help to protect the right to privacy by making the erasure easier from the never-forgetting Internet. However, such erasure may pose considerable threats to another highly important social values, so-called 'reputation capital' in our information-based economy. Customers look for reviews and ratings on goods and services. Employers get opinion on potential employees. Business works hard to build strong positive reputation, for it thrives with good reputation and withers with bad one. As much as a social reputation system is vital to an economic system, any distortion in inference due to the removed "bad names" from search results can be deeply detrimental.

We briefly demonstrate how a broken link may disrupt a reputation system. For discussion's sake, let us consider a client who is looking for professionals such as lawyers, consultants, accountants, etc. when there are two types of professionals, efficient type (E) with probability $P(E) = \theta$ and inefficient type (I) with $P(I) = 1-\theta$, where θ measures the client's prior belief of meeting the efficient. Assume that the efficient type professionals have unblemished reputation with probability $\pi_E = Pr[U|E]$ but blemished with $1-\pi_E = Pr[B|E]$, whereas the inefficient types have unblemished reputation with probability $\pi_I = Pr[U|I]$ such that $0 < \pi_I < \pi_E < 1$. Using the Bayes' rule, we can easily show that the posterior belief for the efficient upon observing the clean reputation decreases as a fraction of the inefficient reset their reputation.

To add some details, without the broken links, the posterior belief $P(E|U)$ is given by

$$P(E|U) = \frac{P(U|E)P(E)}{P(U)} = \frac{P(U|E)P(E)}{P(U|E)P(E) + P(U|I)P(I)} = \frac{\theta\pi_E}{\theta\pi_E + (1-\theta)\pi_I}.$$

Suppose that a proportion ν of the inefficient removed their links under the RTBF regime. Then, the revised posterior belief is updated as

$$\widetilde{P}(E|U) = \frac{\theta\pi_E}{\theta\pi_E + (1-\theta)\left[\pi_I + \nu(1-\pi_I)\right]}.$$

The comparison gives the intuitive result of $P(E|U) > \widetilde{P}(E|U)$ that the agent's posterior belief for the efficient upon the clean reputation goes down as some inefficient types erase their defamatory links.

Remarkably, the changes in the clients' inference from reputation system has not only the *static informational bias* but also— potentially more important— *adverse dynamics*. Suppose that the efficient professionals earn the payoff of V once s/he is matched to and works for the agent. Let the posterior belief also indicate the matching probability (for simplicity). Then, the efficient earn $V \cdot P(E|U)$ without broken links but only $V \cdot \widetilde{P}(E|U)$ with broken links: the return to the clean reputation decreases when the blemished reputation may be washed out. This can lead to vicious dynamics that the more professionals misbehave but later get washed out by the resets, which in turn weaken the incentives to have the good reputation. In this aspect, the value of the right to remember can broadly include any negative effects of the broken links on the system of reputation capital.[29] Thus, the social welfare loss associated with the right to be forgotten and with its global expansion can be substantial when its negative impact on reputation systems is taken into account.

8 Concluding Comments

An individual's online activities leave behind "digital footprints" that are hardly erased. The "data shadows" shaped by the digital footprints has made so-called Big Data analytics possible,[30] but at the same time it would be difficult to deny that such technologies have posed enormous threats to privacy, probably more than the threat to privacy brought by the first compact, film-based Kodak camera in 1888 when the canonical article on the right to privacy Warren and Brandeis (1890) came out. The fundamental issue is 'how to protect a personal dignity from easier exposure and more difficult erasure?' The digital right to be forgotten attempts to protect the private dignity by making the erasure easier. However, one's deletion

[29] As a related point, some argued that the expansion of the European right to be forgotten into the globe may lead to more censorship by public officials such as autocrats who want to whitewash the past or remove links they don't like. Focusing on the economics of the right to be forgotten, we do not take such concerns into account throughout this article. For this point, we refer to the N.Y. TIMES Editorial, *Europe's Expanding 'Right to Be Forgotten'*, Feb. 5. 2015. (`http://www.nytimes.com/2015/02/04/opinion/europes-expanding-right-to-be-forgotten.html?_r=0`)

[30] See Koops (2011).

to be forgotten requires someone else's loss of information to remember. Because the value of dignity (or, privacy) is a socially constructed value (Rosen, 2012a), we observe wide variations in evaluating the trade-off between the right to be forgotten and the right to remember across countries and cultures, highlighted in the recent heated debate on the European ruling on the right to be forgotten and its global expansion.

In this paper we have attempted to pioneer an economic analysis of the right to be forgotten in a stylized legal dispute game framework. Summing up, the present paper predicts, as an equilibrium phenomenon, individual petitioners' aggressive claim behavior and the search engines' generous acceptance in current European environments where the claim process is simple and search engines would face costly litigation or sanctions. We find that the network users' loss from broken links does not monotonically reduce the probability of lawsuits. Thus, it seems reasonable to conclude that the global expansion of the European RTBF itself may not generate a wave of new claims if the court reasonably takes the enlarged loss into account. This observation leads us, necessarily, to a new perspective on the ongoing debate that the expansion should be understood by analyzing an optimal balance between privacy and free speech, rather than by a power game between European data regulators and the dominant search engine, or by a clash between the European privacy rule and the American First Amendment.

Clearly, our paper should be taken as only a first step in an attempt to build the economics behind the right to be forgotten, and we hope other works would follow and complement ours. Particularly, a rigorous empirical research is needed to illuminate whether the current European situation has yielded too many claims and/or too many broken links from the viewpoint of social efficiency. Also, while we have pointed out a theoretical possibility that informational bias from broken links could damage search-based reputation capital, it remains to be seen how such concern would result in practical social costs.

References

Ambrose, M. L., and J. Ausloos (2013): "The right to be forgotten across the pond," *Journal of Information Policy*, 3, 1–23.

Bebchuk, L. A. (1984): "Litigation and Settlement under Imperfect Information," *Rand Journal of Economics*, 15(3), 404–415.

Bennett, S. C. (2012): "The "Right to Be Forgotten": Reconciling EU and US Perspectives," *Berkeley Journal of International Law*, 30(1), 161–195, Available at: http://scholarship.law.berkeley.edu/bjil/vol30/iss1/4.

Bernal, P. (2014): "The EU, the US and Right to be Forgotten," in *Reloading Data Protection*, pp. 61–77. Springer.

Daughety, A. F., and J. F. Reinganum (2014): "Revelation and Suppression of Private Information in Settlement-Bargaining Models," *The University of Chicago Law Review*, pp. 83–108.

Koops, B.-J. (2011): "Forgetting Footprints, Shunning Shadows: A Critical Analysis of the 'Right to Be Forgotten' in Big Data Practice," *SCRIPTed*, 8(3), 229–256, Tilburg Law School Research Paper No. 08/2012. Available at http://dx.doi.org/10.2139/ssrn.1986719.

McNealy, J. E. (2012): "The emerging conflict between newsworthiness and the right to be forgotten," *Northern Kentucky Law Review*, 39(2), 119–135, Available at SSRN: http://ssrn.com/abstract=2027018.

Nalebuff, B. (1987): "Credible pretrial negotiation," *The RAND Journal of Economics*, 18(2), 198–210.

Rosen, J. (2012a): "The Deciders: The Future of Privacy and Free Speech in the Age of Facebook and Google," *Fordham Law Review*, 80, 1525, Available at: http://ir.lawnet.fordham.edu/flr/vol80/iss4/1.

——— (2012b): "The Right to Be Forgotten," *Stanford Law Review Online*, 64, 88, Available at http://www.stanfordlawreview.org/online/privacy-paradox/right-to-be-forgotten?em_x=22.

Walker, R. K. (2012): "The Right to be Forgotten," *Hastings Law Journal*, 64, 257.

Warren, S. D., and L. D. Brandeis (1890): "The Right to Privacy," *Harvard Law Review*, 4(5), 193–220.

A Appendix: Proofs

Proof of Lemma 1. When $\gamma_G = 0$, the left-hand-side (LHS) of (1) is zero and the right-hand side (RHS) takes a positive value of $p_2 C_G > 0$. The LHS is increasing in γ_G with the slope $S > 0$. The slope of the RHS is given by $p_2 S \cdot (g_\gamma \gamma + g)$, which is smaller than S assuming that $g_\gamma \gamma + g < 1$ for any $\gamma \in [0, \bar{\gamma}]$ and $p_2 \in [0, 1]$. By the single crossing property, there exists a unique $\gamma_G > 0$ that satisfies (1). □

Proof of Lemma 2. Follows from the proof of Lemma 1 and the previous discussion in the text. □

Derivation of Assumption 2. We want $\gamma_G < \bar{\gamma}$ to have some types of G reject. Note that γ_G is defined by (1), and is increasing in p_2. Therefore, it suffices to have $\gamma_G < \bar{\gamma}$ at $p_2 = 1$. Define γ_G^* such that it satisfies:

$$\gamma_G^* S = g(h, \gamma_G^*, S)\gamma_G^* S + C_G$$

Then $\gamma_G^* < \bar{\gamma}$ is equivalent to:

$$C_G < \underbrace{(1 - g(h, \gamma_G^*, S))}_{(*)}\bar{\gamma} S. \tag{A.1}$$

Note that as γ_G^* approaches $\bar{\gamma}$, the term $(*)$ increases. Suppose that for $\gamma_G^* = 0$, the condition (A.1) holds. Then for any $\gamma_G^* > 0$, this condition will hold. Therefore if $C_G < (1 - g(h, 0, S))\bar{\gamma} S$, then $\gamma_G^* < \bar{\gamma}$, which implies $\gamma_G < \bar{\gamma}$. Also note that by Lemma 1, $\gamma_G > 0$. Therefore Google will neither accept no matter what her private information is nor reject not matter what her private information is, assuming the petitioner's case has merit (Assumption 1). Rather the petitioner's claim will be accepted by Google whose type is sufficiently low and rejected by Google for whom this is not the case. □

Proof of Lemma 3. The petitioner's expected payoff from litigation (if the claim is rejected) depends on the posterior expectation of γ on the interval $[\gamma_G, \bar{\gamma}]$. If γ_G increases, then $\tilde{\gamma}(\gamma_G) = E[\gamma | \gamma \geq \gamma_G]$ increases (and the expected probability of winning in litigation, $g(h, \tilde{\gamma}(\gamma_G), S)$, decreases), and thus the expected value of litigation falls. Note that by construction, the posterior expectation of γ concentrated on $[\gamma^*, \bar{\gamma}]$ makes P just indifferent between litigation and give-up (that is, (4) holds for $\gamma_G = \gamma^*$). For *(i)*: When $\gamma_G < \gamma^*$, then P's expected payoff from litigation (when a posterior expectation of γ is concentrated on $[\gamma_G, \bar{\gamma}]$) is greater than that when it is concentrated on $[\gamma^*, \bar{\gamma}]$. Therefore when $\gamma_G < \gamma^*$, P must always litigate, i.e., $p_2 = 1$. For *(iii)*: When $\gamma_G > \gamma^*$, $p_2 = 0$ by the similar logic.

For *(ii)*: Lastly when $\gamma_G = \gamma^*$, P's expected payoff from litigation following rejection by the types $\gamma \geq \gamma_G = \gamma^*$ is exactly the expected value when the posterior is concentrated on $[\gamma^*, \bar{\gamma}]$. By construction of γ^*, P is indifferent between litigation and give-up after rejection by the types $\gamma \geq \gamma_G$, and so P follows a randomized strategy $p_2 \in [0, 1]$. $\square$

Proof of Proposition 1. Consider the subgame following the claim. Under Assumption 2, P uses Bayes' theorem to compute his posteriors on G's type when the claim is rejected.
Case (i). Recall that γ_G is defined by (1). It is immediate to see that $\gamma_G \leq \gamma_G^*$ because γ_G is increasing in p_2 and $p_2 \leq 1$. Therefore if $\gamma_G^* < \gamma^*$, then $\gamma_G < \gamma^*$. Given G's cutoff strategy $\gamma_G < \gamma^*$, upon rejection, P's best-response strategy must be $p_2 = 1$ by Lemma 3 (because litigation has a higher expected payoff under the posterior concentrated on $[\gamma_G, \bar{\gamma}]$ than giving up). Against P's strategy $p_2 = 1$, G's best response is to use the cutoff strategy given by γ_G which equals γ_G^* when $p_2 = 1$. Hence, G of types $\gamma \geq \gamma_G^*$ reject the claim and otherwise accept, believing that P will litigate with probability one. This in turn justifies P's optimal strategy to be $p_2 = 1$. This is the only subgame-perfect Nash equilibrium after P's claim.
Case (ii). If $\gamma_G^* \geq \gamma^*$, then $\gamma_G \gtreqless \gamma^*$ depends on P's strategy p_2.

(a) First suppose that $p_2 = 0$. Then it must be $\gamma_G = 0$; i.e., every type of G will reject the claim because she expects P to give up for sure and thus earning zero instead of $-\gamma S$ by accepting the claim. Because $\gamma_G = 0 < \gamma^*$, it must be $p_2 = 1$ by Lemma 3, which is a contradiction. That is, upon rejection by any type, P learns nothing additional about G's type, which implies that his posterior expectation of γ equals his priors; however by Assumption 1, P will prefer litigating to giving up, so $p_2 = 1$.

(b) Now suppose that $p_2 = 1$. Then $\gamma_G = \gamma_G^* (\geq \gamma^*)$. If $\gamma_G > \gamma^*$, then it must be $p_2 = 0$ also by Lemma 3, which again leads to a contradiction. That is, if $\gamma_G > \gamma^*$ and $p_2 = 1$, upon rejection P's expected payoff from litigation when his posterior is on $[\gamma_G, 1]$ is less than that when his posterior is on $[\gamma^*, 1]$; therefore it must be $p_2 = 0$ contradicting $p_2 = 1$. Therefore, if $p_2 = 1$, then it must be $\gamma_G = \gamma_G^*$ and $\gamma_G^* = \gamma^*$. Note that p_2 can be computed by plugging in γ^* in (1):

$$p_2 = \frac{\gamma^* S}{g(h, \gamma^*, S)\gamma^* S + C_G} \underset{\text{by } \gamma^* = \gamma_G^*}{=} \frac{\gamma_G^* S}{g(h, \gamma_G^*, S)\gamma_G^* S + C_G} \underset{\text{by } (5)}{=} \frac{g(h, \gamma_G^*, S)\gamma_G^* S + C_G}{g(h, \gamma_G^*, S)\gamma_G^* S + C_G} = 1,$$

which confirms P's strategy to litigate with probability one.

(c) Lastly suppose that $p_2 \in (0, 1)$. Then it must be $\gamma_G = \gamma^*$ by Lemma 3. Given G's cutoff strategy, P is indifferent between litigation and give-up (See (4)), justifying that

P uses a randomized strategy $p_2 \in (0,1)$. Now P's strategy should confirm that G uses the cutoff γ^*. Plugging γ^* in (1), we have $\gamma^* S = p_2 \left[g(h, \gamma^*, S)\gamma^* S + C_G \right]$, which implies that p_2 is uniquely determined by:

$$p_2 = \frac{\gamma^* S}{g(h, \gamma^*, S)\gamma^* S + C_G}. \tag{A.2}$$

Therefore, believing P randomizes between litigation and give-up with probability given in (A.2), G's best response is to use the cutoff $\gamma_G = \gamma^*$. (Note that when $\gamma^* \le \gamma_G^*$, $p_2 < 1$ implies $\gamma^* S < g(h, \gamma^*, S)\gamma^* S + C_G \le \gamma_G^* S \ \leftrightarrow\ \gamma^* < \gamma_G^*$.)

Thus if $\gamma_G^* \ge \gamma^*$, G's cutoff strategy given by $\gamma_G = \gamma^*$ and p_2 given by (A.2), where $p_2 = 1$ iff $\gamma^* = \gamma_G^*$, is the only subgame-perfect Nash equilibrium following the claim. □

Proof of Proposition 2. Suppose that $\gamma_G^* < \gamma^*$ for given h, S, C_P, and C_G, then $\gamma_G = \gamma_G^*$ and $p_2 = 1$ form a unique equilibrium in the subgame when $p_1 = 1$, where P's posterior expectation of G's types is given by $\mathbb{E}(\gamma | \gamma \ge \gamma_G^*)$. Using backward induction, given the unique subgame equilibrium, if c is such that

$$c \le F(\gamma_G^*)h + (1 - F(\gamma_G^*)) \left[g(h, \tilde{\gamma}(\gamma_G^*), S)h - C_P \right],$$

then P will always prefer "claim" to "no claim." Therefore, P's strategy profile $(p_1, p_2) = (1,1)$, G's cutoff strategy with $\gamma_G = \gamma_G^*$, and P's posteriors $\mathbb{E}(\gamma | \gamma \ge \gamma_G^*)$ upon rejection form a unique sequential equilibrium of this game. If c is larger than the right-hand-side of the above inequality, then $(p_1, p_2) = (0,1)$, $\gamma_G = \gamma_G^*$, and P's posteriors $\mathbb{E}(\gamma | \gamma \ge \gamma_G^*)$ upon rejection form a unique sequential equilibrium. That is, the specified strategies are sequentially rational given the posterior beliefs $\frac{f(\gamma)}{1 - F(\gamma_G)}$ and these beliefs are consistent with such strategies. Sequential equilibrium implies subgame perfection; so if there were multiple sequential equilibria, then there would also be multiple subgame perfect equilibria, contradicting the uniqueness of Nash equilibrium in the subgame specified in Proposition 1. A similar argument proves that there is a unique sequential equilibrium in the case of $\gamma_G^* \ge \gamma^*$ for given h, S, C_P, and C_G, except that now $p_1 = 1$ if $c \le F(\gamma^*)h$ and $p = 0$ if otherwise. □

Proof of Proposition 3. As is evident from (10), there is a kink in $(1 - F(\gamma_G))$ at $\gamma_G^* = \gamma^*$. Let S^* be a value of S such that $\gamma_G^* = \gamma^*$ for given values of h, C_P, and C_G. Differentiation of (10) yields:

$$\frac{dPr(\text{"lawsuits"})}{dS} = (1 - F(\gamma_G)) \underbrace{\left[\frac{\partial p_2}{\partial S} + \frac{\partial p_2}{\partial \gamma_G} \frac{d\gamma_G}{dS} \right]}_{= \frac{dp_2}{dS}} - f(\gamma_G) p_2 \underbrace{\frac{d\gamma_G}{dS}}_{<0}.$$

First consider the case $S < S^*$ (or when $\gamma_G^* < \gamma^*$). For given values of h, C_P, and C_G, Assumption 2 can be rewritten in terms of S such that $S > \underline{S}$ for some $\underline{S} > 0$ such that $(1 - g(h, 0, \bar{S}))\bar{\gamma}\bar{S} = C_G$. These two conditions on S are in strict inequality and so continue to hold for a small change in S. When $S < S^*$, $p_2 = 1$ and $\gamma_G = \gamma_G^*$. Then $\frac{dp_2}{dS} = 0$ and total differentiation of (1) shows that γ_G^* falls as S increases. So the derivative of (10) for $S \in (0, S^*)$ is $-f(\gamma_G^*)\frac{d\gamma_G^*}{dS} > 0$. The probability of lawsuits thus unambiguously increases with an increase in S when $S < S^*$. Next consider the case $S \geq S^*$. Assumption 1 can also be rewritten in terms of S of strict inequality such that $S < \bar{S}$. Thus, for $S \in [S^*, \bar{S})$, the conditions still hold for a small increase in S. When $S \geq S^*$, $p_2 = \frac{\gamma^* S}{g(h,\gamma^*,S)\gamma^* S + C_G}$ and $\gamma_G = \gamma^*$, and so the derivative of (10) for $S \in [S^*, \bar{S})$ is

$$-f(\gamma^*)\frac{d\gamma^*}{dS} + (1 - F(\gamma^*))\frac{dp_2}{dS}, \tag{A.3}$$

where $\frac{dp_2}{dS} < 0$ and $\frac{d\gamma^*}{dS} < 0$. (Differentiation of (4) for $\gamma_G = \gamma^*$ with respect to S shows that γ^* falls as S increases. The derivative of the left-hand-side of (4) with respect to S is negative holding $\gamma_G = \gamma^*$ fixed. Thus a decrease in the value of the left-hand-side of (4) will decrease the borderline type γ^*. Also p_2 monotonically decreases and converges to zero as $S \to \bar{S}$ for $S \geq S^*$.) Note that the right and left derivatives of Pr(“lawsuits”) differ at $S = S^*$. At $S = S^*$, it is a special case where $p_2 = 1$ and $\gamma_G = \gamma^* = \gamma_G^*$; the left derivative evaluated at $S = S^*$ is then $-f(\gamma^*)\frac{d\gamma^*}{dS}$, which is greater than (A.3) at $S = S^*$. Now note that $\lim_{S \to \bar{S}}(1 - F(\gamma^*))p_2 = 0$, whereas $(1 - F(\gamma^*))p_2 > 0$ at $S = S^*$. Hence, the argmax of Pr(“lawsuits”) $\in [S^*, \bar{S})$. Define such argmax to be $\tilde{S}$; then (A.3)> 0 if $S < \tilde{S}$ and (A.3)< 0 if $S > \tilde{S}$,[31] which completes the proof. If we further impose the following condition, then the probability of lawsuits achieves its unique maximum at the kink $\gamma_G^* = \gamma^*$, i.e., $\tilde{S} = S^*$.

Assumption 3. $-f(\gamma^*)\frac{d\gamma^*}{dS}|_{S=S^*} + (1 - F(\gamma^*))\frac{dp_2}{dS}|_{S=S^*} < 0.$

Assumption 3 implies that the right derivative of $\frac{dPr(\text{“lawsuits”})}{dS}|_{S=S^*} < 0$, and continues to be negative for $S > S^*$. □

Proof of Proposition 4. Follows from inspection of (11) and Proposition 3. □

Proofs of Propositions 5 and 6. The proofs follow from discussion in the text. □

Proofs of Corollary 1. Follows directly from Propositions 3 and 4. □

[31] If we assume that $\frac{f(\gamma)}{1-F(\gamma)}$ strictly increases in γ, then the second derivative of Pr(“lawsuits”) is negative whenever (A.3)$= 0$. This ensures uniqueness of $\tilde{S}$. With a aniform distribution $F(\cdot)$, this assumption is not necessary.

Proof of Proposition 7. First, given the primitives that satisfy Assumptions 1 and 2 under both rules, it is immediate from our discussion in text to see that γ^* is lower under the British rule than under the American rule. Since the probability of lawsuits and the likelihood of broken links depend on γ_G^* and whether $\gamma_G^* < \gamma^*$ or $\gamma_G^* \geq \gamma^*$, given other parameters, let us focus on showing that the effect on γ_G^* of changing from the American rule to the British rule is ambiguous. First recall that γ_G^* under the American rule, denoted as γ^A satisfies

$$\gamma^A S = g(h, \gamma^A, S)\gamma^A S + C_G, \tag{A.4}$$

while γ_G^* under the British rule, denoted as γ^B satisfies

$$\gamma^B S = g(h, \gamma^B, S)(\gamma^B S + C_G + C_P). \tag{A.5}$$

If the cutoff type γ^A under the American rule were to compare her loss $\gamma^A S$ from accepting and her expected court loss $g(h, \gamma^A, S)(\gamma^A S + C_G + C_P)$ from rejecting under the British rule, then it depends on h, S, C_P, and C_G whether

$$\begin{aligned} g(h, \gamma^A, S)\gamma^A S + C_G &\lesseqqgtr g(h, \gamma^A, S)(\gamma^A S + C_G + C_P), \\ \leftrightarrow (1 - g(h, \gamma^A, S))C_G &\lesseqqgtr g(h, \gamma^A, S)C_P. \end{aligned} \tag{A.6}$$

If $<$ in (A.6), then $\gamma^B > \gamma^A$; if $>$ then $\gamma^B < \gamma^A$, and if $=$, then $\gamma^B = \gamma^A$. In particular, when h, S, C_P, and C_G are such that $g(h, 0, S)(C_G + C_P) \leq C_G$ (the intercepts of the RHS when $\gamma = 0$ in (A.5) and (A.4) respectively), then $\gamma^B < \gamma^A$ because $g_\gamma < 0$ and so the slope of the RHS of (A.5), $g_\gamma(\gamma S + C_G + C_P) + gS$, is strictly less than the slope of the RHS of (A.4), $g_\gamma \gamma S + gS$. On the other hand, when $g(h, 0, S)(C_G + C_P) > C_G$, then it crucially depends on (A.6). Then it follows that the probability of lawsuits and the likelihood of broken links can either rise, fall, or remain the same depending on the given parameter values, whether $\gamma^B > \gamma^A$, and whether $\gamma^B > \gamma^*$ under the British rule. □

Proof of Lemma 4. γ_G^* is defined by (5), in which we can easily see that γ_G^* is not affected by C_P; Differentiation of (5) with respect to C_G shows that $\frac{d\gamma_G^*}{dC_G} > 0$ holding other variables fixed. On the other hand, γ^*, defined by (4) for $\gamma_G = \gamma^*$, is not affected by C_G while differentiation of (4) with respect to C_P shows that $\frac{d\gamma^*}{dC_P} < 0$. □

Proof of Proposition 8. Lemma 4 implies that $\gamma_G^* < \gamma^*$, Google's optimal cutoff value $\gamma_G = \gamma_G^*$ increases with an increase in Google's litigation cost C_G. Therefore, $Pr(\text{"lawsuits"}) = (1 - F(\gamma_G^*))$ falls with a small increase in C_G when $\gamma < \gamma^*$. On the other hand, when $\gamma \geq \gamma^*$, Google's optimal cutoff value $\gamma = \gamma^*$ is not affect by a change in C_G.

Regardless, $Pr(\text{"lawsuits"}) = (1 - F(\gamma_G^*))p_2$ also falls with an increase in C_G when $\gamma_G^* \geq \gamma^*$, due to the direct negative effect of C_G on $p_2 = \frac{\gamma^* S}{g(h,\gamma^*,S)\gamma^* S + C_G}$. Thus an increase in C_G always leads to a lower probability of lawsuits with a kink at $\gamma_G^* = \gamma^*$. For the likelihood of broken links, when $\gamma_G^* < \gamma^*$, it is given by $Pr(\text{"broken links"}) = F(\gamma_G^*) + (1 - F(\gamma_G^*))g(h, \tilde{\gamma}(\gamma_G^*), S)$. As C_G increases more types of G accept (i.e., the first term increases); while the probability of lawsuits, $(1 - F(\gamma_G^*))$ and the expected probability of the petitioner winning in court, $g(h, \tilde{\gamma}(\gamma_G^*), S)$, both fall, and so the multiplication of these two terms falls (i.e., the second term decreases). But a decrease in the second term is dominated by an increase in the first term, because otherwise, for a small $\varepsilon > 0$, it must be:

$$\begin{aligned} F(\gamma_G^* + \varepsilon) - F(\gamma_G^*) &\leq (1 - F(\gamma_G^*))g(h, \tilde{\gamma}(\gamma_G^*), S) - (1 - F(\gamma_G^* + \varepsilon))g(h, \tilde{\gamma}(\gamma_G^* + \varepsilon), S), \\ &< g(h, \tilde{\gamma}(\gamma_G^*), S)(F(\gamma_G^* + \varepsilon) - F(\gamma_G^*)), \end{aligned}$$

where the inequality holds because $g(h, \tilde{\gamma}(\gamma_G^*), S) > g(h, \tilde{\gamma}(\gamma_G^* + \varepsilon), S)$. This gives a contradiction because $g(h, \tilde{\gamma}(\gamma_G^*, S)) < 1$. When $\gamma_G^* \geq \gamma^*$, the likelihood of broken links is given by $Pr(\text{"broken links"}) = F(\gamma^*) + (1 - F(\gamma^*))p_2 g(h, \tilde{\gamma}(\gamma^*), S)$. An increase in C_G does not affect the interval of Google's type who accept. This implies that P's expected probability of winning remains the same; however higher C_G lowers P's probability of choosing litigation, and thus the probability of broken links falls. □

Proof of Proposition 9. Lemma 4 implies that when $\gamma_G^* < \gamma^*$, γ_G^* is not affected by C_P. We can then easily observe that $Pr(\text{"lawsuits"}) = (1 - F(\gamma_G^*))$ remains constant by any small change in C_P when $\gamma_G^* < \gamma^*$. Moreover, because γ_G^* does not change, both the probability of rejection by Google (and obviously the probability of acceptance) and P's expected winning probability stay the same. Thus $Pr(\text{"broken links"}) = F(\gamma_G^*) + (1 - F(\gamma_G^*))g(h, \tilde{\gamma}(\gamma_G^*), S)$ also remains constant. On the other hand, when $\gamma_G^* \geq \gamma^*$, γ^* decreases with an increase in C_P. So, the effect of an increase in C_P on $Pr(\text{"lawsuits"}) = (1 - F(\gamma^*))\left(\frac{\gamma^* S}{g(h,\gamma^*,S)\gamma^* S + C_G}\right)$ seems not obvious because we need to consider an indirect effect of C_P on $Pr(\text{"lawsuits"})$ through γ^*. Let C_P^* denote the value of C_P such that $\gamma_G^* = \gamma^*$. Then for $C_P \in [C_P^*, \bar{C}_P)$ (or when $\gamma_G^* \geq \gamma^*$), we have:

$$\begin{aligned} \frac{dPr(\text{"lawsuits"})}{dC_P} &= \frac{\partial Pr(\text{"lawsuits"})}{\partial \gamma^*}\frac{d\gamma^*}{dC_P} \\ &= -f(\gamma^*)p_2\frac{d\gamma^*}{dC_P} + (1 - F(\gamma^*))\frac{\partial p_2}{\partial \gamma^*}\frac{d\gamma^*}{dC_P}, \end{aligned} \tag{A.7}$$

where the first term is positive because $\frac{d\gamma^*}{dC_P} < 0$ by Lemma 4, whereas the second term is negative because $\frac{\partial p_2}{\partial \gamma^*} > 0$. Note that the left and right derivatives differ at $C_P = C_P^*$. The left derivative evaluated at $C_P = C_P^*$ is zero (because $p_2 = 1$ and $\gamma_G = \gamma_G^* = \gamma^*$ at $C_P = C_P^*$); whereas the right derivative evaluated at $C_P = C_P^*$ is $(1 - F(\gamma^*))\frac{dp_2}{dC_P}|_{C_P=C_P^*} < 0$. The derivative (A.7) remains negative for $C_P \in (C_P^*, \bar{C}_P)$ assuming $\frac{f(\gamma)}{1-F(\gamma)}$ strictly increases in γ. Therefore, Pr(“lawsuits”) $= (1-F(\gamma^*))p_2$ decreases in C_P when $\gamma_G^* \geq \gamma^*$. For the likelihood of broken links in this case, we have Pr(“broken links”) $= F(\gamma^*)+(1-F(\gamma^*))p_2 g(h, \tilde{\gamma}(\gamma^*), S)$, where $F(\gamma^*)$ decreases and $1 - F(\gamma^*)$ increases by an increase in C_P; however any increase in $(1 - F(\gamma^*))$ is dominated by the decrease in the second term. So the likelihood of broken links also decrease in C_P when $\gamma_G^* \geq \gamma^*$. $\square$