The Economics of the Right to be Forgotten*

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Abstract

We offer an economic analysis of the right to be forgotten (RTBF)—the right to remove links from the search results—through a legal dispute game between a petitioner and a search engine. Our analysis suggests that the global expansion of the RTBF does not necessarily increase the likelihood of link removals. We also find that the RTBF expansion can either improve or reduce welfare from a social perspective. Therefore, the ongoing debate should be guided by the perspective of achieving a socially optimal level of link removals rather than of a conflict between privacy rights and free speech.

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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, the 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 Inc. 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 erase the pertinent links from Google's search results on Costeja's name.[1]

The court further ruled that the operator of a search engine is obliged to remove from the list of search results, when requested by an individual, certain links to web pages that contain 'inadequate, irrelevant or no longer relevant, or excessive' information about that person. After the so-called "right to be forgotten" ruling, Google launched an online request process on May 29, 2014 and received more than 300,000 link-removal requests from individuals in the European Union (EU) and the European Free Trade Association (EFTA).[2] Table 1 shows data on the total number of requests Google received and the percentages of URLs that Google reviewed and removed.

Despite Google's effort to comply with the European ruling on the right to be forgotten (RTBF), the scope of such right has become extremely controversial. The privacy watchdogs in the EU issued guidelines in September 2014 calling on Google to apply the European ruling to all of its global domains. They argued that the local

[1] See Case C-131/12 *Google Spain SL, Google Inc. v Agencia Española de Protección de Datos (AEPD), Mario Costeja González* [2014] ECLI:EU:C:2014:317.

[2] Yahoo Inc. and Microsoft also started to take the requests for search result removals from Yahoo Search and Bing, respectively. Further, the right to be forgotten is more broadly applicable to any Internet data operators not just search engines. Our focus in this paper is on Google as a representative player because as of October 2014, Google's search market share in Europe dominated Bing (2.67%), Yahoo (2.34%), and others (1.52%) at more than 90% according to StatCounter.

Table 1: European privacy requests for search removals on Google

Country	Total requests	Total URLs evaluated	% URLs removed
All EU and EFTA	**309,093**	**1,093,087**	**41.5**
France	64,486	211,529	47.9
Germany	52,900	197,867	48.1
U.K.	38,626	146,401	37.7
Spain	29,171	91,290	36.6
Italy	23,085	76,850	28.5

Source: `https://www.google.com/transparencyreport/removals/europeprivacy/` (as of August 30, 2015)

delisting was not effective and complete protection of data subjects' rights to erasure and blocking of data. However, Google restricted its compliance by removing the links from search results only on its European domains. This restriction was based on Google's interpretation that the guidelines were not binding beyond the EU's 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.

The controversy primarily stems from institutional and conceptual differences in how Europeans and Americans perceive the related rights (See Ambrose and Ausloos (2013), Bennett (2012), Bernal (2014), McNealy (2012), Rosen (2012a,b), and Walker (2012)).[3] As Rosen (2012b) notes, the right to be forgotten in Europe finds its intellectual root in the French law of *le droit à l'oubli*: a convicted criminal has a right to oppose the publication of his or her criminal history after serving time. On the other hand, such a right is in conflict with the First Amendment to the US Constitution that protects freedom of speech.[4] In the meantime, according to a recent

[3]For a case in point on this contrast, see Schwartz, John. 2009. "Two German Killers Demanding Anonymity Sue Wikipedia's Parent." *New York Times*, November 12, A13. http://www.nytimes.com/2009/11/13/us/13wiki.html.

[4]McNealy (2012) indicates that while some US plaintiffs have recently attempted to assert the right to be forgotten through the US privacy law, the US courts have seldom allowed the removal of certain information from the press. Instead, plaintiffs have relied on the tort of invasion of privacy that can grant relief to an injured party from the public disclosure of private information. For example, see Purtz v. Srinvisan, No. 10CESC02211 (Fresno Co. Small Cl. Ct. Jan. 11, 2011) in McNealy (2012).

poll by Benenson Strategy Group, 88 percent of US registered voters support a law that would grant them the right to petition operators of search engines to remove certain personal information that appear in search engine results.[5]

At the heart of this debate lie several conflicting interests. First, individuals want to avoid the harm that can be incurred from search results that are defamatory, embarrassing, or misleading. However, the removal of those links can generate certain costs to operators of search engines as well as to internet users who would otherwise easily find desired information via the links. As much as the right to remove such links (or the right to be forgotten) appears indispensable to privacy rights, the right to retain such links is also essential for the protection of other fundamental rights, such as freedom of speech and open access to information. Therefore, the debate on the global expansion of the RTBF is framed as the tension between the right to privacy and freedom of speech as represented by link removal. That is, European data regulators prescribe the RTBF expansion as a way to remove more links and to protect data subjects' privacy rights, whereas the opponents argue for implementing removals only on local domains under the pretext of protecting free speech.

We argue that they miss an important point: It is too simple and not sufficient to associate the expansion of the *scope* of the RTBF to all domain extensions of the search engine with the expansion of the *resulting* link removals. Because the expansion of the RTBF can change the internet users' loss associated with link removals on a global scale, it can also influence individuals' behavior and search engines' response, and thus have important effects on the number of link removals. Failures to account for these possible connections may lead to the conclusion that the expansion necessarily encroach on freedom of speech and can result in prescriptions that reduce social welfare.

A proper study must account for how the global expansion of the RTBF impacts the incidence of link removals as well as for how it affects social welfare. To answer

[5]The report on this poll is available at http://beltway.bsgco.com/content/privacy-and-tech.

these questions, one needs to understand the equilibrium probability of link removal and the efficient probability of link removal. In this paper, we undertake these two tasks and draw a finer economic analysis on the related issues regarding the RTBF expansion. The payoff of our approach is that it offers a theoretical framework to handle those nuanced considerations and pushes for a reformulation of the debate on the global expansion of the RTBF.

To flesh out our analysis, we consider a legal dispute game between a petitioner and a search engine, based on the models of Bebchuk (1984) and Nalebuff (1987). The search engine has private information about its type, which represents loss from removing the links. We assume that this loss is positively related to the loss of the search engine's users who are deprived of the links. The petitioner who allegedly suffers harm from the search results can request their removal at a fee of some positive amount. The search engine can either accept or reject the claim. If the claim is rejected, the petitioner can either give up or proceed to litigation against the search engine, which is costly for both parties. The equilibrium of this game predicts that as long as the claim fee is sufficiently small, the petitioner will act aggressively and request the removal of the links in hopes of their request being accepted and, if rejected, has the option to proceed to litigation for the potential to win in court. At rejection, litigation always ensues if the petitioner's harm is large; otherwise litigation still arises with a positive probability.

The equilibrium probability of link removal conveniently summarizes how an increase in the search engine users' loss from the removal of links, denoted by S, impacts equilibrium behavior and the consequent occurrence of link removals. We find that the equilibrium probability of link removal unambiguously decreases with an increase in S. The key reasoning behind this result is that the search engine is less likely to accept a link-removal claim under a higher S. Even if the petitioner's win in court following his litigating at rejection might increase a chance of the removal, such an increase (if any) is marginal and is dominated by the effect of the search engine's less acceptance because the petitioner is expected to win in court less often.

Next, we define and characterize an efficiency benchmark designed to address whether the equilibrium of our game is socially inefficient either in terms of the search engine's response to a claim or in terms of the expected link removal. The efficiency benchmark identifies the efficient probability of link-removal if a social planner were to maximize social welfare and appropriately dictates the removal of links. We find that once the petitioner files the claim to remove links when the search engine users' loss from the removal is sufficiently large, the search engines with small loss accept the claim to avoid costly litigation or a potential sanction, and as a result the links are removed; whereas, social efficiency rather calls for the retention of the links in such case. In this sense, for the cases with relatively large S, too many claims are accepted by the search engine and render socially undesirable link removals. We also find that the link removal that is expected to arise in equilibrium is socially deficient for a low range of S and socially excessive for a high range of S. The reason is that the petitioner's uncertainty about the search engine's loss leads to a bias in the petitioner's estimation of the expected outcome of a trial; in particular, the petitioner underestimates his winning probability at trial when S is relative small, whereas the petitioner overestimates when otherwise.

Using our equilibrium and efficiency analyses, we discuss the effects of the RTBF expansion on link removals and welfare. If the removal of links is applied to all domain names of the search engine globally, we can reasonably expect the search engine users' loss from link removals to be larger. Our key prediction then is that the likelihood of link removals would decrease by the global expansion. Further, we demonstrate that the RTBF expansion can achieve the socially optimal level of link removals only if the internet users' loss is relatively low. What is essential here is that the expansion does not necessarily imply better or worse social outcomes; it can be either welfare-improving or welfare-reducing under certain conditions. Therefore, we argue that the global expansion of the right to be forgotten should not be taken as a threat to the right of free speech and access to information nor can it be justified as an effort to strengthen privacy rights; rather, it should be understood by analyzing the optimally balanced level of protecting both privacy rights and freedom of speech as represented by the socially optimal level of link removals. In this sense, our paper sheds a new light on the debate of the global expansion of the right to be forgotten.

The remainder of the paper is organized as follows. Section 2 presents the model and characterizes the equilibrium. Section 3 discusses the interpretation of the model in connection to current situation over the RTBF. Section 4 and Section 5 provide the equilibrium and efficiency analyses. Section 6 explores various implications on the global expansion of the RTBF. Section 7 offers concluding comments. All proofs are in Appendix A. A number of appendices available online address several extensions and variations of our framework. The purpose of these appendices is both to demonstrate the robustness of our results to changes in the modeling assumptions and to delve deeper into the theoretical results that are relevant to the RTBF issue.

2 The Model

2.1 Setup

We consider the game in which two risk-neutral parties are in a potential legal conflict over the right to be forgotten (RTBF), referred to as a *RTBF* game.[6] A petitioner, P, alleges that he suffers harm, $h > 0$, from the links (pertinent to him) provided on a web search engine such as Google, G.[7] Google loses $L \geq 0$ if they remove the links. Even if G does not experience a direct monetary loss from the removal, L captures various costs that are incurred from complying with the RTBF ruling. For example, search engines might lose search efficiency due to removed links. The removal of links

[6]The basic setup of our game closely resembles Bebchuk (1984) and Nalebuff (1987). While they focus on pretrial settlement negotiation between a plaintiff and a defendant, we rule out the possibility of a settlement demand by a petitioner (plaintiff) because pretrial bargaining opportunities are not prevalent in the cases of the RTBF.

[7]For exposition, we use male pronouns for P and female pronouns for G. Again, we note that G can represent any data operator subject to the RTBF ruling.

might also impose costs on the search engine's users. In particular, some users might need to exert more effort (or might even fail) to find the exact content without the links offered by the search engine. To capture such an externality, we denote $S \geq 0$ as the total loss to the search engine users if the links are removed. We assume that L is positively related to S because a larger loss to users is likely to yield a higher loss to the search engine. Specifically we let $L = \gamma S$ where γ is possibly greater than one. In our RTBF game, h and S are common and public knowledge, whereas γ is G's private information. The petitioner believes that γ is drawn from a non-degenerate distribution $F(\cdot)$ over the interval $[0, \bar{\gamma}]$ with density $f(\cdot)$.

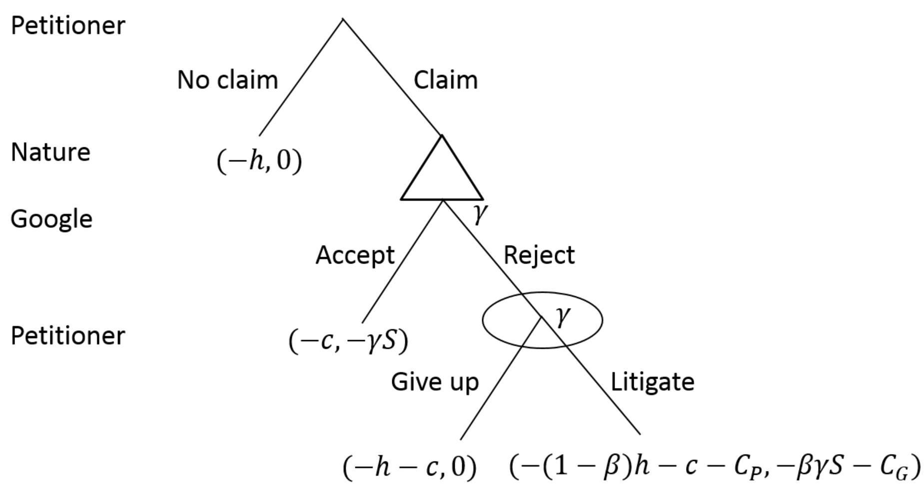

Figure 1: The game tree

The game tree illustrated in Figure 1 describes the sequence of events. The P first chooses either to "claim" (i.e., requests G to remove the links) at a fee of $c > 0$, or to make "no claim." The P makes this decision without knowing G's γ. Once P files a claim, G then decides whether to "accept" or "reject" the claim. If G accepts and removes the links, then she loses γS, and P receives the payoff $-c$. If G rejects, then P has to choose whether to "litigate" or "give up" while still not knowing G's γ. If P gives up and the links are not removed, P's payoff is $-h-c$ and G's payoff is zero. If P litigates and a trial takes place, then the litigation costs to P and G are $C_P > 0$

and $C_G > 0$ respectively. If $\beta \in [0,1]$ is the likelihood of P prevailing in a trial, then P wins the trial and the links are removed with probability β; P loses the trial and the links are retained with probability $1-\beta$. Under the American rule on litigation costs, the expected payoffs from litigation then are $-(1-\beta)h - c - C_P$ for P and $-\beta\gamma S - C_G$ for G.

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. Further, the ruling might be affected by social norms of a given jurisdiction. Taking these two considerations into account yields a general function for β with minimal restrictions on how the trial's expected outcome depends on the factual issues. Formally, the likelihood of P prevailing in a trial is given by $\beta \equiv g(h,\gamma,S)$ where g is a twice-differentiable function and its partial derivatives satisfy $g_h \geq 0$, $g_\gamma \leq 0$, and $g_S \leq 0$ for all (h,γ,S). 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 that ensures that G's best responses are well defined; the second condition requires a strictly increasing-differences property on G's expected payoffs—the marginal value of switching from accepting to rejecting monotonically increases with G's type—that is essential for keeping the analysis tractable.

The G's private information allows her to make a better assessment of the likelihood of the petitioner prevailing in a trial; in fact, G knows exactly that she will lose the trial with probability $g(h,\gamma,S)$. On the other hand, P does not know the exact value of γ but has a prior expectation of γ given $F(\cdot)$, denoted by $\mathbb{E}[\gamma]$; hence, P estimates his ex-ante expected probability of winning to be $g(h,\mathbb{E}[\gamma],S)$.

2.2 Extensions

There are some natural extensions to our specification of the setup. We mention a few of these directions, although the detailed discussions are presented in the online appendices.

First, the petitioner might be the one who has private information or incomplete information might be two-sided. Our model can be adjusted to apply to the case where P knows h and G only knows its distribution from which h is drawn, or to the case where both parties are uncertain about the adversary's payoff-relevant type. While we will not fully characterize equilibria under such information structures, we briefly discuss those possibilities in online Appendix D. We note that Google's uncertainty about the petitioner's harm does not appear to be an issue of significance in the ongoing debate over the RTBF.

Second, one may consider models with alternative legal rules governing the allocation of litigation costs. In our setup we assume the *American rule* that each party bears his or her own litigation costs in case of a trial regardless of the trial's outcome. But in some cases, a losing party might bear all of the litigation costs—the legal arrangement that is referred to as the *British rule*. The model developed above can be used to examine our game under the British rule by modifying accordingly the parties' expected payoffs from litigation. We examine how equilibrium behavior is affected by a change from the American rule to the British rule in online Appendix E. But all of our subsequent results apply in this case as well. Thus the general conclusions of this paper are robust to alternative specifications of legal rules on litigation costs.

Third, the court ruling of a trial can be assumed that it is determined by the social welfare maximizing rule, and the parties estimate correspondingly their winning probability in a trial given their information. We can easily incorporate this additional assumption in our model by characterizing $g(h, \gamma, S)$ as a specific functional form that takes into account that the expected outcome of a trial is socially optimal. We discuss this extension at length in online Appendix F. The underlying mechanisms for the theoretical results are essentially the same; yet this analysis permits us to explore the potential sources of inefficiency that arises in the game, supplementing our efficiency analysis.

2.3 Equilibrium

We now characterize conditions under which a court-imposed settlement can arise as an equilibrium outcome and analyze this game.

The petitioner's strategy is represented by (p_1, p_2) where the first component indicates P's probability of claiming; the second is his conditional probability of litigating if the claim is rejected. Let us consider the subgame following P's claim. In this subgame, G with type γ compares the payoff from accepting, $-\gamma S$, with the expected payoff from rejecting, $(1-p_2)\cdot 0 + p_2\left[-g(h,\gamma,S)\gamma S - C_G\right]$, when G has anticipated that P will choose to litigate according to p_2. We define γ_G to be the borderline type of G who is indifferent to accepting or rejecting the claim if she 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 $p_2 > 0$.*

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

Lemma 2. *G's best response against any strategy of P, p_2, is using a cutoff strategy with the cutoff type γ_G that is defined by (1); in particular,*

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

(ii) Gs of type $\gamma < \gamma_G$ accept the claim.

Now P at his decision-node after the claim has been rejected forms a posterior expectation of γ concentrated on $[\gamma_G, \bar{\gamma}]$ given by

$$\tilde{\gamma}(\gamma_G) \equiv \mathbb{E}[\gamma|\text{“claim is rejected”}] = \mathbb{E}[\gamma|\gamma \geq \gamma_G] = \int_{\gamma_G}^{\bar{\gamma}} \frac{xf(x)}{1-F(\gamma_G)}dx \tag{2}$$

where $\tilde{\gamma}(\gamma_G)$ is a monotonically increasing function of γ_G.[8] Accordingly, P updates his expected probability of winning to be $g(h, \tilde{\gamma}(\gamma_G), S)$ and compares his payoff from giving up, $-h-c$, with the expected payoff from litigation,

$$-\left(1-g(h,\tilde{\gamma}(\gamma_G),S)\right)h - c - C_P. \tag{3}$$

This expected payoff monotonically falls with γ_G because $g_\gamma \leq 0$ and $\tilde{\gamma}(\cdot)$ increases with γ_G.

We restrict our attention to the range of parameter values where litigation can arise as an equilibrium outcome. Such restriction requires two conditions that rule out the cases where P always gives up at rejection regardless of his posterior expectations or G always accepts the claim no matter what her γ is. In both cases, litigation never arises as an equilibrium outcome.

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

Condition 1 states that litigating is ex-ante profitable to P, which implies that P prefers litigating over giving up even if all types of G reject (so that P's posterior belief is identical to his prior belief over G's type).[9] Even when Condition 1 holds, P might not litigate with certainty; because if more types of G accept, P lowers his posterior expectation of the winning probability possibly enough to opt for giving up. If the parameter values are such that the condition is violated, then there is a unique equilibrium to the subgame following P's claim in which all Gs reject and P always gives up at rejection.

Condition 2. $\gamma_G < \bar{\gamma}$.

[8] This monotonic increase holds for any generic distribution $F(\gamma)$ as long as it is non-atomic over the interval $[0, \bar{\gamma}]$. The reasoning is that when more types accept, the interval of types that reject decreases (i.e., γ_G rises up), and the expected γ increases.

[9] 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 to assuming that litigation is profitable against G of the highest type $\bar{\gamma}$. However, the litigation is not always credible and thus we impose Condition 1 that is a weaker version of Bebchuk's (1984) and equivalent to Nalebuff's (1987) assumption that P's case has merit.

Condition 2 rules out the case where even the highest type of G does not have an interest in rejecting the claim.[10] If Condition 2 does not hold, then the equilibrium characterization is trivial because all Gs will accept the claim in the unique subgame equilibrium.

Under Condition 2, some types of G will always reject, that is, $1 - F(\gamma_G) > 0$. Upon rejection, P 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. The petitioner's strategy p_2 must be optimal given G's optimal cut-off strategy characterized by γ_G. We define γ^* to be a 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 P indifferent between litigating and giving up at rejection by the types above γ^*.[11] It trivially follows that $\gamma^* > 0$ from Condition 1.

Lemma 3. *P's best response at rejection by Gs of type $\gamma \geq \gamma_G$ is:*

(i) If $\gamma_G < \gamma^*$, then $p_2 = 1$;

(ii) If $\gamma_G = \gamma^*$, then $p_2 \in [0, 1]$;

(iii) If $\gamma_G > \gamma^*$, then $p_2 = 0$.

We define γ_G^* as the cut-off type of G that is indifferent between accepting or rejecting the claim when G believes that P will litigate with certainty at rejection. That is, γ_G^* satisfies:

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

We then characterize a unique equilibrium to the continuation subgame after P's claim as follows.

[10] A sufficient condition that ensures Condition 2 to be satisfied is derived in Appendix A.

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

Proposition 1. *Under Conditions 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 Gs of type $\gamma < \gamma_G^*$ accept the claim; Gs of type $\gamma \geq \gamma_G^*$ reject it, and P always litigates, $p_2 = 1$;

(ii) If $\gamma_G^* \geq \gamma^*$, then Gs of type $\gamma < \gamma^*$ accept the claim; Gs of type $\gamma \geq \gamma^*$ reject it, and P litigates 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, that is, $\frac{f(\gamma)}{1-F(\gamma_G)}$, where γ_G is the cutoff value of G's strategy.

The equilibrium strategies described above form the unique equilibrium in behavioral strategies. Under Condition 2, the rejection state occurs with positive probability in the unique equilibrium, thus the equilibrium strategies are always sequentially rational for P at rejection with the beliefs specified above.[12]

We explain the intuition for Proposition 1 as follows. First for the case of $\gamma_G^* < \gamma^*$, at rejection by Gs of type $\gamma \geq \gamma_G^*$, litigation is profitable to P because $g(h, \tilde{\gamma}(\gamma_G^*), S) > g(h, \tilde{\gamma}(\gamma^*), S) = C_P$; hence, P's optimal strategy $p_2 = 1$ and G's optimal cut-off type γ_G^* are justified. By contrast, if $\gamma_G^* \geq \gamma^*$, then P's commitment to litigation is not credible because it induces rejection only by Gs of type $\gamma \geq \gamma_G^*$, which in turn makes P's litigation unprofitable because $g(h, \tilde{\gamma}(\gamma_G^*), S) \leq g(h, \tilde{\gamma}(\gamma^*), S) = C_P$. Hence, P lowers his probability of litigating so as to induce Gs of type $\gamma \in [\gamma^*, \gamma_G^*)$ also reject; P now faces a greater chance of being rejected, but after rejection by Gs of type $\gamma \geq \gamma^*$, P is indifferent between litigating or giving up, which confirms his optimal strategy $p_2 \in (0, 1]$. The $\gamma_G^* = \gamma^*$ is a special case in which $\gamma_G = \gamma^*$ and $p_2 = 1$.

We now consider 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 the claim is

[12] The beliefs are weakly consistent with the equilibrium in behavioral strategies. Because $1 - F(\gamma_G) > 0$ by Condition 2, rejection is never a zero-probability event. Then upon rejection, Bayes' formula completely characterizes P's belief probabilities, and Bayes' consistency implies full consistency of beliefs. Thus weak sequential equilibrium implies full sequential equilibrium.

obtained under the prior distribution of G's types given the equilibrium strategies specified in Proposition 1 as follows:

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

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

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

The right-hand side of (7) is interpreted as P's expected benefit from choosing "claim" over "no claim." The reasoning is straightforward: the claim fee has to be small enough for claiming to be profitable to P assuming that all of the moves after the claim are determined according to the strategies specified in Proposition 1. Adopting the tie-breaking rule that P chooses to claim when (7) holds as equality, we can summarize the analysis as follows.

Proposition 2. *Under Conditions 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.*

Proposition 2 implies that as long as the claim fee is small enough, a petitioner with sufficient harm will act aggressively and request the removal of the defamatory links. The petitioner does so in the hope that the search engine will accept his request; and if the search engine rejects the request, the petitioner expects to win in court with a positive probability. Both of these scenarios lead to the removal of the links.

Further, in the case where Condition 1 fails, there is still a unique sequential equilibrium in which P never claims, all Gs reject, and P always gives up. In the case where Condition 2 fails, there is a unique sequential equilibrium in which P claims if

$c \leq h$ and does not claim if otherwise, all Gs accept, and P always litigates, where rejection of the claim is a zero-probability event.

3 The Interpretation of the Model

The framework we have developed is amenable to a number of interpretations that are relevant for Europe's current situation over the RTBF. We discuss some of the potential interpretations of our model and its assumptions.

Interpretation of the payoff parameters.

In the setup, we define S as the search engine users' loss from the removal of links that is requested by a data subject (referred to as a petitioner in the model). The parameter S essentially captures the magnitude of any negative externality that is suffered by the internet users as a result of deleted links that would otherwise help them easily find desired information. In this sense, S can be interpreted as the interest of the general public in having easy access to the information in question upon a search relating to the data subject's name. Further, the parameter S can also include social costs due to any distortion in a reputation system from the so-called 'Internet memory hole.'[13] Interested readers are referred to online Appendix G for a formal development on this kind of concern.

While we assume that L is positively related to S in our model, one might also argue a potential positive correlation between h and S. For instance, the network users' loss from the removal of links would presumably increase with their search intensity, and the petitioner's harm from the links might also depend on the search intensity. We can accommodate this consideration in our model by replacing h with δS for some $\delta > 0$. In fact, the general tenor of our results continue to hold in this case as long as γ remains private information to G. However, we do not impose any deterministic relation between h and S in the setup. The primary justification

[13]See Mcelroy, Wendy. 2014. "The Internet Memory Hole." *The Freeman*, November 24. http://fee.org/freeman/the-internet-memory-hole.

comes from our interpretation of h as an individual's subjective disutility from the fact itself that the links related to that person are publicly available in an online search; the size of which is somewhat independent from the search intensity of that person's name but rather depends mostly on individual characteristics—personal or professional—as well as the individual's own sensitivity to the nature of the searched information. For example, an ordinary Joe might perceive disutility from the links to web pages that contain his criminal history as much as a well-known public figure might, although a greater intensity of searches for the public figure is reasonably expected. Also, a lawyer might have relatively larger harm from the search results on his home foreclosure notice than, say, a florist because such past is more detrimental to the legal profession. Our assumption that h is independent from S simplifies the exposition of the results while conveying all the key insights.

Interpretation of the players.

While we describe the RTBF game as a legal dispute between a search engine and a single individual petitioner, the interpretation of the players in our model can be more flexible. When we apply the model to the Costeja's case, it might be reasonable that the ECJ and Google both perhaps correctly expected that many similar requests would follow after Costeja's win and, as a result, the search engine might need to handle numerous removal requests immediately. Under this view, the expected court ruling should depend on the *aggregate* values of the parameters. In particular, S would measure the aggregate loss to the search engine users from the link removals in all cases, and L would reflect the search engine's aggregate loss from all ensuing cases. Further, the court ruling should also consider aggregate harm of all individual petitioners who are expected to claim the removal against the search engine. Because we do not restrict the function $g(h, \gamma, S)$ in a specific form, the model can be modified to reflect this view of aggregate payoffs (though the petitioner still decides based on his own payoff), which implies that our qualitative results will remain intact under this interpretation.

Interpretation of litigation.

After the European ruling on the Costeja's case, any individual in the EU and EFTA member countries can make a request for the removal of links through a web form at the search engine's web site. Particularly for Google, the removals process work as follows: For each submitted request, Google evaluates whether the search results include outdated or inaccurate information about the person and weighs whether or not there is a preponderant interest of the general public in having access to the information in question upon a search relating to the requester's name. When Google declines to remove certain links, an individual can request a data protection authority to review Google's decision. For example, the Information Commissioners' Office (ICO) in the United Kingdom has handled over 183 complaints from individuals that disagree with Google's rejection. The ICO contends that Google had correctly rejected about three-quarters of them. However the ICO did not agree with Google's assessment in 48 cases and asked Google to revise their decision.[14] Google might face discipline should it not accept the ICO's request for the revision. From this perspective, the "litigation" in our model can be broadly interpreted as a mechanism, beyond an actual lawsuit, that determines the payoffs to the search engine and the petitioner when the petitioner does not give up after the initial rejection by the search engine.

Interpretation of the equilibrium predictions under Conditions 1 and 2.

In our equilibrium characterizations, Conditions 1 and 2 rule out the cases in which there is no possibility of litigation either because P always gives up or because G always accepts. The equilibrium characterizations under these conditions (Proposition 2) can be interpreted as giving a reasonable approximation to describing Europe's current situation over the right to be forgotten. After the European ruling, Google received a considerable amount of removal requests and rejected over 50 percent of

[14] See Rawlinson, Kevin. 2015. "Google in 'right to be forgotten' talks regulator." *BBC News*, May 13. http://www.bbc.com/news/technology-32720944.

those requests. Given that the request process is easily accessible to individuals and that search engines face costly litigation or a sanction following their rejections, our focus on the equilibrium under Conditions 1 and 2 is justified.

In terms of S, Conditions 1 and 2 exclude the cases when S is very large and very small respectively. We provide an illustrative example of our game in online Appendix B, and show a complete characterization of equilibria for all possible values of S given other parameter values. Further, for each potential case for the RTBF claim, the payoff-relevant parameter values may vary. Then, taking the expectation over some distribution of all possible cases will yield a measure of the overall rejection rate of the search engine. Although in principle this task is technically feasible by assuming an appropriate joint distribution of (h, S, C_P, C_G, c), we do not pursue it in this paper.

4 Comparative Statics

In this section, we examine the effect of a change in the search engine users' loss S on the probability of link-removal in equilibrium, that is, the likelihood that the links will be removed as a result of either the acceptance of the claim or the petitioner's win at trial. This comparative statics provides an important implication on the debate over the global expansion of the RTBF that is discussed in Section 6.

In our RTBF game, the removal of links as a resulting equilibrium outcome occurs only if the claim is made. Hence, we assume that the claim fee is sufficiently small so that the condition (7) is always satisfied. Then under Conditions 1 and 2, the unique sequential equilibrium of the RTBF game entails $p_1 = 1$ for any given parameter values. We refer to an equilibrium in which $p_1 = 1$ as a *claim equilibrium.*

In the claim equilibrium, the links are removed in either of the following cases: G accepts the claim; or G rejects and P litigates and wins. In equilibrium, the total prior probability that G accepts the claim is $F(\gamma_G)$ and the probability that P litigates is p_2 with P's expected probability of winning to be $g(h, \tilde{\gamma}(\gamma_G), S)$. Thus, the *equilibrium* *probability of link-removal* is given by:

$$Pr(\text{“link-removal”}) \equiv F(\gamma_G) + (1 - F(\gamma_G))p_2 g(h, \tilde{\gamma}(\gamma_G), S) \tag{8}$$

An observation of (8) shows that, in the claim equilibrium, $(1 - F(\gamma_G))p_2$ is the likelihood that the claim will proceed to court on the equilibrium path, which we refer to as the *probability of lawsuits.* Therefore, we find it useful to begin with examining the probability of lawsuits. Taking into account the equilibrium strategies characterized in Proposition 1, this probability can be computed as follows:

$$Pr(\text{“lawsuits”}) = \begin{cases} (1 - F(\gamma_G^*)) \cdot 1 & \text{if } \gamma_G^* < \gamma^*, \\ (1 - F(\gamma^*)) \cdot \left(\dfrac{\gamma^* S}{g(h, \gamma^*, S)\gamma^* S + C_G} \right) & \text{if } \gamma_G^* \geq \gamma^*. \end{cases} \tag{9}$$

Because G's optimal cutoff value γ_G (either γ_G^* or γ^*) decreases with S, the probability of G's rejection, $(1-F(\gamma_G))$, unambiguously increases with S with a kink at $\gamma_G^* = \gamma^*$. When $\gamma_G^* < \gamma^*$, the probability that P litigates remains $p_2 = 1$ regardless of a change in S; hence, a higher S in this case has a correspondingly higher probability of lawsuits. However when $\gamma_G^* \geq \gamma^*$, a higher S has an ambiguous effect on the probability of lawsuits because $p_2 = \frac{\gamma^* S}{g(h,\gamma^*,S)\gamma^* S + C_G}$ decreases with S.

To formalize this result, we define S^* to be the value of S such that $\gamma_G^* = \gamma^*$ and $\bar{S}$ to be the upper bound of S that is implied by Condition 1, given the other primitives. We assume that $\frac{f(\gamma)}{1-F(\gamma)}$ strictly increases with γ, which ensures a unique maximum of the probability of lawsuits; this assumption makes the analysis tractable but is not essential for the main insights. Then we arrive at the following proposition.

Proposition 3. *For any 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 $S \geq \tilde{S}$ for a unique $\tilde{S} \in [S^*, \bar{S})$.*

Proposition 3 asserts that the probability of lawsuits achieves its maximum at

$\tilde{S} \geq S^*$. Under a certain condition on the right derivative of the probability of lawsuits evaluated at $S = S^*$, the maximum occurs at $\tilde{S} = S^*$. The condition is given in the proof of Proposition 3. Assuming that this condition holds, we give the reasoning behind Proposition 3 as follows. If S increases, the probability of G's rejection increases with a kink at $S = S^*$. First 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 commit to litigate with probability one. Therefore, a higher probability of G's rejection contributes to an increase in the probability of lawsuits. On the other hand, when $S \geq S^*$, the increased probability of G's rejection by an increase in S makes P's litigation unprofitable compared to giving up. That is, P is no longer able to litigate with probability one; at rejection, P has to litigate less often to compensate for his expected loss from litigation. Such a fall in P's probability of litigating more than offsets the increased probability of rejection by G when $S \geq S^*$. Thus, the overall probability of lawsuits falls.

We now assess the probability of link-removal as a resulting equilibrium outcome. Surprisingly, we find that the probability of link-removal shows a monotonic decrease by an increase in S.

Proposition 4. *For any given h, C_P, and C_G, the probability of link-removal unambiguously decreases with an increase in S.*

Figure 2 illustrates Proposition 4 for the example that is given in online Appendix B. To understand the reasoning behind Proposition 4, we decompose the two channels through which an increase in S affects the probability of link-removal that is characterized by (8). First for the case when $\gamma_G^* < \gamma^*$:

$$Pr(\text{“link-removal”}) = \overbrace{F(\gamma_G^*)}^{(1)} + \overbrace{\underbrace{(1 - F(\gamma_G^*))}_{=Pr(\text{“lawsuits”})} g(h, \tilde{\gamma}(\gamma_G^*), S)}^{(2)}.$$

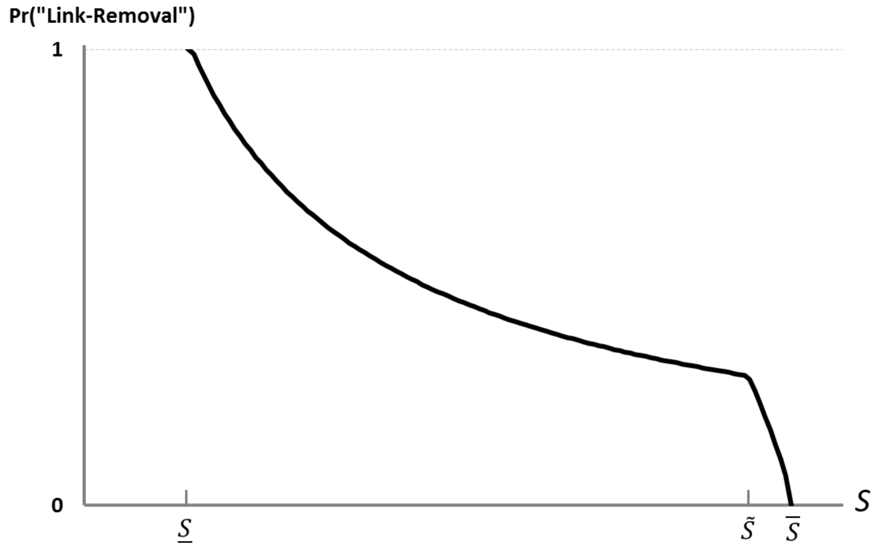

Figure 2: The effect of S on the equilibrium probability of link-removal

As S increases given other parameter values, less Gs accept; so term (1) falls, contributing to less chance of the links being removed as a result of G's acceptance. At the same time, more Gs reject so $Pr($"lawsuits"$)$ increases but P's posterior assessed probability of winning in court falls; hence, whether term (2) rises or falls is ambiguous. Regardless, the effect of term (1) is stronger than the effect of term (2) because P's expected winning probability is less than one, thus a decrease in term (1) more than offsets any increase in term (2). Similarly for the case when $\gamma_G^* \geq \gamma^*$:

$$\overbrace{F(\gamma^*)}^{(1')} + \overbrace{\underbrace{(1 - F(\gamma^*)) \left(\frac{\gamma^* S}{g(h, \gamma^*, S)\gamma^* S + C_G} \right)}_{=Pr(\text{“lawsuits”})} \underbrace{g(h, \tilde{\gamma}(\gamma^*), S)}_{(*)}}^{(2')}.$$

As is evident from the previous discussion, term $(1')$ falls with S. In term $(2')$, P's expected probability of winning, term $(*)$, is constant (and less than one). The reason is that when $\gamma_G^* \geq \gamma^*$, P is just indifferent between litigating and giving up after rejection by Gs of $\gamma \geq \gamma^*$, which implies that his posterior assessed probability of winning must remain the same regardless of a change in S. Also in term $(2')$,

Pr("lawsuits") decreases with S for any $S \geq \tilde{S} \geq S^*$. If $\tilde{S} = S^*$, then term (2′) unambiguously falls with S; even if $\tilde{S} > S^*$ so that Pr("lawsuits") increases for $S \in [S^*, \tilde{S})$, the marginal increase in term (2′) is less than the marginal decrease in term (1′).

Regardless of whether $\gamma^*_G < \gamma^*$ or $\gamma^*_G \geq \gamma^*$, an increase in S unambiguously lowers the equilibrium probability of link-removal with a kink at $S = \tilde{S}$. For a higher users' loss from the removal of links, P expects that the court is more likely to rule in favor of G, which together with a lower probability of G's acceptance of the claim contributes to a lower chance of link-removal. This effect is exacerbated when users' loss is so high such that P starts to give up more often.

Another important factor that shapes the probability of lawsuits and of link-removal is the magnitude of the parties' litigation costs. We offer the comparative statics with regard to C_G and C_P in online Appendix C.

5 Equilibrium versus Social Efficiency

We now introduce an efficiency benchmark that serves as an instrument for addressing whether the equilibrium of our RTBF game is socially inefficient. We study two types of inefficiency: one in the sense that G's acceptance renders socially undesirable link removals and the other in the sense that the probability of link-removal in equilibrium is not optimal from a social perspective.

We define our efficiency benchmark as follows. Consider a social planner whose objective is to maximize the ex-post social welfare that amounts to the total payoffs of the petitioner, the search engine, and the search engine users less fixed costs. By ex post, we mean that the claim fee and litigation costs are not included in the social planner's computation.[15] The social planner dictates whether to remove the links or not. In our model the ex-post social welfare is given by $-(\gamma S + S)$ if the links are removed and by $-h$ otherwise. Thus the social planner's decision depends on whether

[15] This exclusion does not derive the result; rather, it obviates a trivial argument that social welfare is maximized under a no claim equilibrium when fees are high enough.

h is higher than $\gamma S + S$ or not. For any given h, γ, and S, if $h > \gamma S + S$, then the social planner, or *social efficiency*, calls for the links to be removed while the links are to be retained if $h \leq \gamma S + S$. We define the social planner's *efficiency cutoff*, γ^e, as the highest possible type of G against whom the social planner would dictate removal for any given h and S. Formally,

$$\gamma^e = \begin{cases} \bar{\gamma} & \text{if } h \geq \bar{\gamma} S + S, \\ \frac{h-S}{S} & \text{if } S < h < \bar{\gamma} S + S, \\ 0 & \text{if } h \leq S. \end{cases} \tag{10}$$

This efficiency benchmark thus identifies the best a society could do if an omniscient, omnipotent, benign planner controls the link removals.

To examine when a claim equilibrium is considered inefficient in the sense that G's acceptance might lead to socially undesirable link removals, we adopt the following definition. We say that a claim equilibrium renders *excessive acceptance* of the claim on the equilibrium path if there is a positive probability that G's acceptance results in the removal of links when that removal should not happen from a social efficiency perspective. Then we have the following proposition.

Proposition 5. *For any given parameter values, if $\gamma^e < \gamma_G$, then the claim equilibrium renders excessive acceptance of the claim.*

The condition $\gamma^e < \gamma_G$ implies that G is of type $\gamma \in (\gamma^e, \gamma_G)$ with some positive probability for a non-degenerate distribution of γ. Social efficiency calls for the links to be retained against Gs of such type because $\gamma > \gamma^e$; but this G accepts the claim in equilibrium because $\gamma < \gamma_G$ and as a result the links are removed. Such removal is undesirable from a social perspective.

Figure 3 illustrates Proposition 5 by plotting the social planner's efficiency cutoff and G's optimal cutoff type in relation to S. The shaded area below the cutoff type γ_G and above the efficiency cutoff γ^e indicates the types of G who will accept the claim in equilibrium and against whom social efficiency requires the links to be retained for given h and S. Therefore the social planner, who finds out that G is of type $\gamma \in (\gamma^e, \gamma_G)$, dictates that Gs of such type should reject and P should not claim the removal in the first place (so that the links are not removed).[16] In this sense, one might reasonably expect to see too many claims are accepted by G compared to the social optimum among all cases with any h and S such that $S > \frac{h}{\gamma_G+1}$.

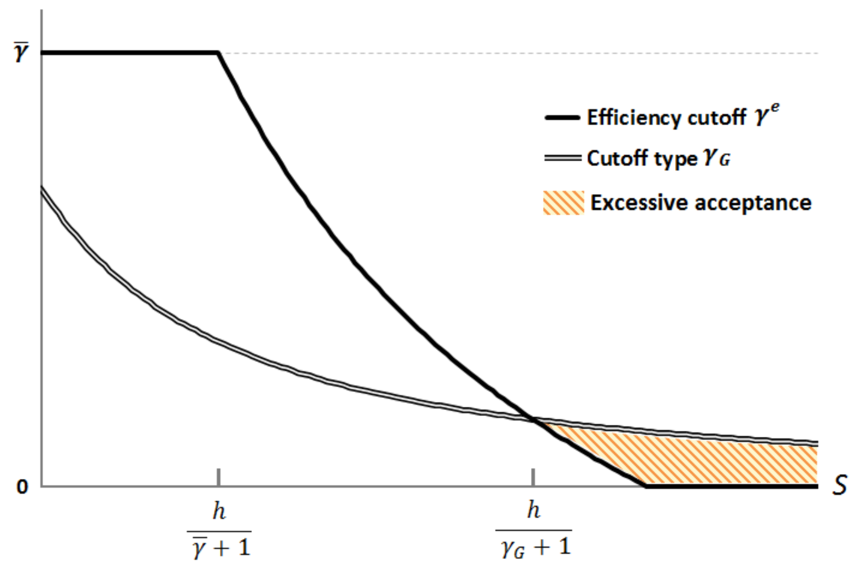

Figure 3: Excessive acceptance of claims

We now turn to study the conditions under which the equilibrium of the RTBF game is socially inefficient in terms of the expected link removal. According to our definition of the efficiency cutoff, the *efficient probability of link-removal* is given by

$$Pr^e(\text{"link-removal"}) \equiv F(\gamma^e) = \begin{cases} 1 & \text{if } h \geq \bar{\gamma}S + S, \\ F\left(\frac{h-S}{S}\right) & \text{if } S < h < \bar{\gamma}S + S, \\ 0 & \text{if } h \leq S. \end{cases} \tag{11}$$

[16]The social planner can perfectly control the actions of P and G if not dictating removal or retention directly.

The efficient probability of link-removal is interpreted as the expected probability of link-removal from the perspective of an "outsider" (as a game theorist who analyzes this problem) when the social planner who maximizes social welfare dictates the outcome of whether to remove the links or not.

We let Pr^*("link-removal") denote the expected probability of link-removal evaluated at equilibrium—the equilibrium probability of link-removal that is given by (8). In principle, we can say that the sequential equilibrium of the RTBF game is socially inefficient in terms of the link removal that is expected to arise in equilibrium if Pr^*("link-removal") $\neq Pr^e$("link-removal").

In any claim equilibrium, the social planner's "assessment" of P's winning probability upon rejection by Gs of type $\gamma \geq \gamma_G$ can be defined as follows:

$$g^e(\gamma^e; \gamma_G) \equiv \begin{cases} \frac{F(\gamma^e)-F(\gamma_G)}{1-F(\gamma_G)} & \text{if } \gamma_G \leq \gamma^e, \\ 0 & \text{if } \gamma_G > \gamma^e. \end{cases} \tag{12}$$

That is, if $\gamma_G > \gamma^e$, then all Gs that reject are of the types against whom the social planner would dictate retention of links. Thus the social planner assigns zero winning probability to P for a given claim after rejection by Gs of those types. However if $\gamma_G \leq \gamma^e$, then Gs of type $\gamma \in [\gamma_G, \gamma^e]$ reject the claim in equilibrium, although the social planner would have dictated removal against such types. Hence, the social planner requires that P wins against Gs of type $\gamma \in [\gamma_G, \gamma^e]$ and loses against Gs of type $\gamma \in (\gamma^e, \bar{\gamma}]$.

For a complete comparison between the equilibrium and efficient probabilities of link-removal, we also consider a *no-claim* equilibrium that is defined as the unique sequential equilibrium of the RTBF game in which $p_1 = 0$. The equilibrium probability of link-removal in the no-claim equilibrium is trivially zero. We arrive at the following results.

Proposition 6. *For any given parameter values of the RTBF game:*

(i) In a no-claim equilibrium,

$$Pr^e(\text{“}\textit{link-removal}\text{”}) > Pr^*(\text{“}\textit{link-removal}\text{”}) = 0 \quad \textit{if } h > S;$$
$$Pr^e(\text{“}\textit{link-removal}\text{”}) = Pr^*(\text{“}\textit{link-removal}\text{”}) = 0 \quad \textit{if } h \leq S.$$

(ii) In a claim equilibrium,

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

Proposition 6-*(i)* implies that if $h > S$, a no-claim equilibrium is socially inefficient in the sense that the equilibrium probability of link-removal is lower than the efficient probability of link-removal. This is because if P's harm is greater than the search engine users' loss, then (10) implies $\gamma^e > 0$; so the social planner will find at least some low types of G who should remove the links but against whom P had not filed the claim in the first place. On the other hand, if $h \leq S$, the social planner prefers retention of the links for all Gs, and so the no-claim equilibrium is socially efficient.

Proposition 6-*(ii)* implies that the link removal that is expected to arise in the claim equilibrium is considered deficient (resp. excessive) from the viewpoint of social efficiency if P underestimates (resp. overestimates) his winning probability in court; in other words, P's posterior expectation of γ after rejection is less (resp. greater) than the highest possible type against whom the social planner would dictate removal. When $g(h, \tilde{\gamma}(\gamma_G), S) = g^e(\gamma^e; \gamma_G)$, the equilibrium probability of link-removal exactly coincides with the efficient probability of link-removal because P "correctly" updates his belief on the types of G who will reject and against whom the social planner would dictate removal. In such a case, the expected amount of removed links in the claim equilibrium achieves social efficiency. Figure 4 illustrates Proposition 6-*(ii)* in terms of S, where $\hat{S}$ is defined to be the value of S that satisfies $g(h, \tilde{\gamma}(\gamma_G), \hat{S}) = g^e(\gamma^e; \gamma_G)$ for a given value of h.

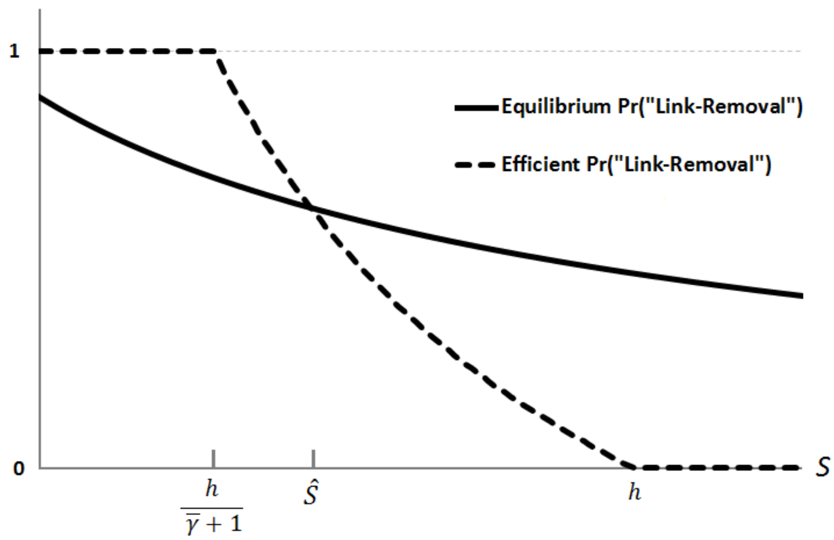

Figure 4: Equilibrium versus efficient probability of link-removal

Beyond the theoretical underpinnings, Proposition 6 suggests a testable empirical prediction. If all factual information on the true values of h, γ, and S are available as well as the outcome of every RTBF case, then we can establish the socially efficient outcome for each case and compare that with its actual outcome. The actual outcome can be categorized into one of the following three cases: (i) the removal or the retention of the links are socially efficient; (ii) the links are not removed when they should have been removed from a social efficiency perspective; or (iii) the links are removed when they should have been retained. If the second cases are prevalent, then we can say that the RTBF is under-protected relative to the socially efficient level. On the other hand, if the third cases prevail, then freedom of speech is under-protected beyond the optimally balanced level.

6 The Global Expansion of the Right to be Forgotten

The privacy watchdogs in the European Union have called on Google to apply the European ruling to its global search results by claiming that local deletion does not effectively protect the data subjects' privacy rights. However, Google's advisory council interpret the ruling as not binding beyond the EU's jurisdiction. Thus Google's compliance with the European ruling has been limited only to the European domains of its search engines. As a result, Google's evaluations of the removal requests depend on its assessment of the requester's harm and the users' loss pertaining only to the *local* domain. The debate on whether to expand the European ruling to all of Google's global domains is still ongoing.

Underlying the debate is the supposition that expanding the scope of the RTBF to all domain extensions of the search engine will cause more links to be removed. The advocates of the global expansion framing the issue in this way argue that the expansion is a means to strengthen the protection of privacy rights as represented by more link removals. On the other hand, those who oppose to the expansion fear that it poses a threat to freedom of speech and access to information because the expansion will delete more links that could help search engine users easily find desired information. However, both sides of the debate fail to account for the possible change in the size of the internet users' loss if the links are removed globally as a result of the global expansion of the RTBF.

If this connection is taken into account, then the expansion will influence the behaviors of potential petitioners and search engines; thus it can have important effects on the likelihood that the links are removed either by the search engine's acceptance of the claims or by the court-imposed settlements. Therefore, we examine the following questions by using the preceding analyses: How would the global expansion affect the probability that the search engine will accept the link-removal claim and the probability that the case will proceed to court? Would the expansion increase the likelihood of link removals as a result?

We argue that if the removal of the links is applied in a global manner, then the search engine users' loss from the resulting removal is larger. In this sense, our key presumption is that the global expansion can be interpreted as an increase in S. We further assume that h remains constant under the expansion. Justification follows from our interpretation that the petitioner suffers harm from the fact that defamatory links are publicly available in a web search. That is, the size of the petitioner's harm is somewhat independent from where the links are listed and could be searched for, or from how many internet users view the related links; rather, of more relevance is the extent that the links are out there instead of to what extent the links are being deleted. Therefore, in the perspective of the petitioner, there is not much additionally saved by expanding the scope of the domains on which the relevant links are removed. In a similar vein, because other search engines than Google or domains other than ".com" are easily accessible anyway, we suspect that the global expansion might increase the size of the harm that the petitioner suffered already. On the other hand, while the search engine users can circumvent the local deletion by using other domains, expanding the scope of deletion furthermore hinders the users' easy access to information.[17]

Taking into account that the global expansion increases S given a fixed h, Propositions 3 and 4 directly imply the following argument.[18]

Corollary 1. *If the global expansion increases S, then it has the following effects:*

(i) The probability that a search engine will accept a link-removal claim decreases;

(ii) The probability that a claim will be settled in court can either increase or decrease;

(iii) The expected probability of the resulting link removal unambiguously falls.

Corollary 1 does not necessarily imply that the global expansion decreases the total number of the links that are removed among all of the removal claims. In order to evaluate this, we need to estimate the change in the number of claims due to the expansion as well as the change in the number of the links that are requested for

[17] The interpretations of h and S are elaborated in Section 3.

[18] Even if the possibility of an increase in h under the expansion is taken into account, the effect of a change in h would not likely dominate the effect of a change in S, in our opinion, to such a degree that the expansion leads to a more favorable ruling for a petitioner. Needless to say, if the relative change of S to h is larger, then the messages derived from Corollary 1 remain intact qualitatively.

removal (which may vary across claims). However we note that the total number of all the removed links is not a meaningful measure for assessing whether the expansion is a threat to freedom of speech or a reinforcement of privacy rights. What is essential is that the global expansion of the RTBF ruling lessens the possibility of each removal claim resulting in the removal of the links mainly because the search engine will decline the removal claims more often. Thus we can expect that the overall likelihood of link removals will decrease by the expansion.

An important implication of Corollary 1 is that establishing the expansion can hardly be justified as an effort to strengthen the protection of privacy as argued by some European data regulators nor can it necessarily be a threat to the right of free speech and access to information. In fact the expansion might make less link removals. In this sense, our assertion sheds a new light on the debate for global expansion: The debate should not be framed as a clash between protecting privacy rights and freedom of speech. Rather, the expansion should be applied and assessed in the perspective of finding a socially optimal balance between privacy and free speech.

In particular, our discussion of social efficiency in Section 5 renders a policy implication on how to deal with the expansion. Proposition 6 implies that the expansion does not necessarily make better social outcomes. Depending on whether the link removal in equilibrium is expected to be excessive or deficient as well as on the magnitude of that inefficiency, the expansion can move the welfare either closer to or further from the social optimum and its welfare effect is not monotonic. Therefore, our efficiency analysis demonstrates that the expansion should be seen from the perspective of achieving the socially optimal level of link removals.

7 Conclusion

An individual's online activities leave behind "digital footprints" that are hard to erase. The "data shadows" shaped by the digital footprints have made the so-called Big Data analytics possible, but at the same time it would be difficult to deny that such technologies have posed enormous threats to privacy.[19] The fundamental issue is 'how to protect personal dignity from easier exposure and more difficult erasure?' The digital right to be forgotten attempts to protect private dignity by making the erasure easier. However, one's erasure requires someone else's loss in having access to information. Because the value of private dignity 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 free speech across countries and cultures. This is highlighted in the recent heated debate on the European "right to be forgotten" ruling and its global expansion.

In this paper, we have attempted to pioneer an economic analysis of the right to be forgotten issue in a stylized legal dispute game. We predict, as an equilibrium phenomenon, the individuals' aggressive removal request and the search engines' generous acceptance in current European environments where the request process is simple and search engines face costly litigation or sanctions. We find that a higher search engine users' loss from the removal of the links unambiguously lowers the equilibrium probability of link-removal. This results suggests that the global expansion of the right to be forgotten may not generate a wave of link removals. Further, the observation that the welfare effect of the global expansion is not monotonic leads us to a new perspective on the ongoing debate: the expansion should be understood by analyzing an optimal balance between removal and retention of links from a social perspective, rather than by a power game between European data regulators and the search engine, or by a clash between the European privacy law and the American First Amendment.

This 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 will follow and complement ours. Particularly, a rigorous empirical research is needed to illuminate whether

[19] See Koops (2011) for more discussion on the right to be forgotten in Big Data practices. For various recent articles on the economics of privacy, see Acquisti et al. (2015) and the references therein.

the current European situation has yielded too many claims and/or too many link removals from the viewpoint of social efficiency. Also, while we point out a theoretical possibility that informational bias from removed links could damage search-based reputation capital, it remains to be seen how such a concern would result in practical social costs.

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A Appendix A: 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 for any $p_2 \in [0, 1]$ by the assumption that $g_\gamma \gamma + g < 1$, $\forall \gamma \in [0, \bar{\gamma}]$. By the single crossing property, there exists a unique $\gamma_G > 0$ that satisfies (1). □

Proof of Lemma 2. The proof follows from the proof of Lemma 1 and the discussion that precedes Lemma 2 in the text. □

A sufficient condition for Condition 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 $p_2 = 1$. The γ_G^* is defined in (5). Then $\gamma_G^* < \bar{\gamma}$ if and only if

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

As γ_G^* approaches $\bar{\gamma}$, the term $(*)$ increases. Therefore, if the condition (A.1) holds for $\gamma_G^* = 0$, then this condition will hold for any $\gamma_G^* > 0$. Therefore if $C_G < (1 - g(h, 0, S))\bar{\gamma} S$, then $\gamma_G^* < \bar{\gamma}$, which implies $\gamma_G < \bar{\gamma}$. □

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). Thus the expected value of litigation falls. By construction of (4), the posterior expectation of γ concentrated on $[\gamma^*, \bar{\gamma}]$ makes P just indifferent between litigating or giving up. For case *(i)*: If $\gamma_G < \gamma^*$, 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, P must always litigate, that is, $p_2 = 1$. For case *(ii)*: If $\gamma_G = \gamma^*$, then P's expected payoff from litigation following rejection by Gs of type $\gamma \geq \gamma_G = \gamma^*$ is exactly the expected value when the posterior is concentrated on $[\gamma^*, \bar{\gamma}]$. By construction of γ^*, P is indifferent between litigating and giving up, and so P follows a randomized strategy $p_2 \in [0, 1]$. For case *(iii)*: If $\gamma_G > \gamma^*$, then $p_2 = 0$ by the similar logic as in the case *(i)*. □

Proof of Proposition 1. Consider the subgame following the claim. Under Condition 2, P uses Bayes' theorem to compute his posteriors on G's type when the claim is rejected. For 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 type $\gamma_G < \gamma^*$, at rejection P's best-response strategy must be $p_2 = 1$ by Lemma 3. Against P's strategy $p_2 = 1$, G's best response is to use the cutoff strategy with the cutoff type γ_G which equals γ_G^* when $p_2 = 1$. Hence, Gs of type $\gamma \geq \gamma_G^*$ reject the claim and otherwise accept, believing that P will litigate with probability one. This in turn justifies P's optimal strategy to be $p_2 = 1$. These strategies of G and P constitute the only subgame-perfect Nash equilibrium after P's claim. For 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 γ_G must equal 0; that is, all Gs reject the claim because G expects P to definitely give up and thus earns zero by rejecting instead of $-\gamma S$ by accepting. But because $\gamma_G = 0 < \gamma^*$, p_2 must equal 1 by Lemma 3, which is a contradiction. That is, at rejection by all Gs, P learns nothing additional about G's type, which implies that his posterior expectation of γ equals his priors; however by Condition 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 p_2 must equal 0 also by Lemma 3, which again leads to a contradiction. That is, if $\gamma_G > \gamma^*$ and $p_2 = 1$, at 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 $p_2 = 0$, which contradicts $p_2 = 1$. 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 γ^* into (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 if $p_2 \in (0,1)$, then it must be $\gamma_G = \gamma^*$ by Lemma 3. Given G's cutoff strategy, P is indifferent between litigating and giving up (See (4)), which justifies 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^* into (1), we have $\gamma^* S = p_2 [g(h,\gamma^*,S)\gamma^* S + C_G]$, 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 that P randomizes between litigating and giving up with the probability given in (A.2), G's best response is to use the cutoff type $\gamma_G = \gamma^*$.

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

Proof of Proposition 2. If $\gamma_G^* < \gamma^*$ 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 $\mathbb{E}(\gamma|\gamma \geq \gamma_G^*)$. Given this unique subgame equilibrium, the condition (7) becomes

$$c \leq F(\gamma_G^*)h + (1 - F(\gamma_G^*))\,[g(h,\tilde{\gamma}(\gamma_G^*),S)h - C_P] \tag{A.3}$$

where we use $p_2 = 1$ and $\gamma_G = \gamma_G^*$. Using backward induction, if c is such that (A.3) holds, then P always prefers "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 $\mathbb{E}(\gamma|\gamma \geq \gamma_G^*)$ at 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 $\mathbb{E}(\gamma|\gamma \geq \gamma_G^*)$ at 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 are multiple sequential equilibria, then there also are multiple subgame perfect equilibria, which contradicts the uniqueness of Nash equilibrium in the subgame specified in Proposition 1. If $\gamma_G^* \geq \gamma^*$ for given h, S, C_P, and C_G, then given the subgame equilibrium strategies specified in Proposition 1, (7) becomes $c \leq F(\gamma^*)h$ because $[g(h, \tilde{\gamma}(\gamma_G), S)h - C_P] = 0$ and $\gamma_G = \gamma^*$. Then a similar argument as in the previous case of $\gamma_G^* < \gamma^*$ proves that there is a unique sequential equilibrium in which $p_1 = 1$ if $c \leq F(\gamma^*)h$ and $p = 0$ if otherwise. □

Proof of Proposition 3. As is evident from (9), 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 $Pr(\text{"lawsuits"}) \equiv (1 - F(\gamma_G))p_2$ with respect to S yields:

$$\frac{dPr(\text{"lawsuits"})}{dS} = (1 - F(\gamma_G)) \underbrace{\left[\frac{\partial p_2}{\partial S} + \frac{\partial p_2}{\partial \gamma_G}\frac{d\gamma_G}{dS}\right]}_{=\frac{dp_2}{dS}} - f(\gamma_G)p_2 \underbrace{\frac{d\gamma_G}{dS}}_{<0}. \tag{A.4}$$

First consider the case $S < S^*$ (or when $\gamma_G^* < \gamma^*$). For any given values of h, C_P, and C_G, Condition 2 can be rewritten in terms of S as follows: $S > \underline{S}$ where $\underline{S} > 0$ is a unique value of S that satisfies $\gamma_G^* = \bar{\gamma}$. Because $S < S^*$ is in strict inequality, $S < S^*$ continues to hold for a small change in S. For $S < S^*$, we have $p_2 = 1$ and $\gamma_G = \gamma_G^*$ in equilibrium. Then $\frac{dp_2}{dS} = 0$, and total differentiation of (5) shows that γ_G^* falls as S increases. So for $S \in (\underline{S}, S^*)$, (A.4)$= -f(\gamma_G^*)\frac{d\gamma_G^*}{dS} > 0$. The probability of lawsuits thus unambiguously increases with an increase in S when $S < S^*$. Next consider the case $S \geq S^*$ (or when $\gamma_G^* \geq \gamma^*$). Condition 1 can also be rewritten in terms of S as a strict inequality condition such that $S < \bar{S}$. Thus, for $S \in [S^*, \bar{S})$, the boundary condition still holds for a small increase in S. For $S \geq S^*$, we have $p_2 = \frac{\gamma^* S}{g(h,\gamma^*,S)\gamma^* S + C_G}$ and $\gamma_G = \gamma^*$ in equilibrium, and so (A.4) for $S \in [S^*, \bar{S})$ can be rewritten as

$$-f(\gamma^*)p_2 \frac{d\gamma^*}{dS} + (1 - F(\gamma^*))\frac{dp_2}{dS}. \tag{A.5}$$

In (A.5), we have $\frac{d\gamma^*}{dS} < 0$ because differentiation of (4) 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) decreases the borderline type γ^*). Also $\frac{dp_2}{dS} < 0$ because p_2 monotonically decreases and converges to zero as $S \to \bar{S}$ when $S \geq S^*$. 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.5) 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") $\in [S^*, \bar{S})$. Under the assumption that $\frac{f(\gamma)}{1-F(\gamma)}$ strictly increases with γ, the second derivative of Pr("lawsuits") is negative whenever (A.5)$= 0$. This ensures a unique argmax of Pr("lawsuits"). (With a uniform distribution $F(\cdot)$, this assumption is not necessary.) Define such argmax to be $\tilde{S}$; then (A.5)> 0 if $S < \tilde{S}$ and (A.5)< 0 if $S \geq \tilde{S}$, which completes the proof. If we further impose the following condition, then the probability of lawsuits achieves its unique maximum at the kink $\gamma_G^* = \gamma^*$ so that $\tilde{S} = S^*$.

Condition 3. $-f(\gamma^*)p_2\frac{d\gamma^*}{dS}|_{S=S^*} + (1 - F(\gamma^*))\frac{dp_2}{dS}|_{S=S^*} < 0.$

This condition implies that the right derivative $\frac{dPr(\text{"lawsuits"})}{dS}|_{S=S^*} < 0$; then the assumption that $\frac{f(\gamma)}{1-F(\gamma)}$ strictly increases with γ implies that (A.5) continues to be negative for $S > S^*$. □

Proof of Proposition 4. The proof follows from the detailed discussion on the decomposition of (8) given after Proposition 4 along with Proposition 3. □

Proofs of Proposition 5. If $\gamma^e < \gamma_G$ for any given parameter values, then the prior probability that G is of type $\gamma \in (\gamma^e, \gamma_G)$ is positive for any non-degenerate distribution $F(\cdot)$ of γ. In any claim equilibrium, Gs of such type accept the claim (because $\gamma < \gamma_G$) and as a result the links are removed. The social planner dictates retention of the links against Gs of type $\gamma > \gamma^e$ by the definition of our efficiency benchmark and (10). Hence, there is a positive probability, $F(\gamma_G) - F(\gamma^e) > 0$, that G's acceptance (in particular by the types $\gamma \in (\gamma^e, \gamma_G)$) results in the removal of links when that removal should not happen from a social efficiency perspective. Thus by the definition of excessive acceptance, there is excessive acceptance of the claim on the equilibrium path of a claim equilibrium if $\gamma^e < \gamma_G$. □

Proofs of Proposition 6. For case *(i)*: In a no-claim equilibrium, the link removal cannot occur as an equilibrium outcome because $p_1 = 0$. Thus, $Pr^*(\text{“link-removal”}) = 0$ for any given parameter values, whereas $Pr^e(\text{“link-removal”}) > 0$ if $h \leq S$ by (11). For case *(ii)*: If $g(h, \tilde{\gamma}(\gamma_G), S) < g^e(\gamma^e; \gamma_G)$, then $\gamma_G \leq \gamma^e$ (because otherwise, we have $g(h, \tilde{\gamma}(\gamma_G), S) < 0$, which is a contradiction); and so $g^e(\gamma^e; \gamma_G) = \frac{F(\gamma^e) - F(\gamma_G)}{1 - F(\gamma_G)}$ by (12). Then,

$$\begin{aligned}
Pr^*(\text{“link-removal”}) \equiv & F(\gamma_G) + (1 - F(\gamma_G))p_2 g(h, \tilde{\gamma}(\gamma_G), S) \\
< & F(\gamma_G) + (1 - F(\gamma_G))p_2 g^e(\gamma^e; \gamma_G) \\
= & F(\gamma_G) + p_2[F(\gamma^e) - F(\gamma_G)] = [F(\gamma_G) - F(\gamma^e)](1 - p_2) + F(\gamma^e) \\
\leq & F(\gamma^e) \equiv Pr^e(\text{“link-removal”}),
\end{aligned}$$

where the first inequality follows from $g(h, \tilde{\gamma}(\gamma_G), S) < g^e(\gamma^e; \gamma_G)$ and the second (weak) inequality follows because $[F(\gamma_G) - F(\gamma^e)] \leq 0$. Hence, $Pr^e(\text{“link-removal”}) > Pr^*(\text{“link-removal”})$ if $g(h, \tilde{\gamma}(\gamma_G), S) < g^e(\gamma^e; \gamma_G)$. Now if $g(h, \tilde{\gamma}(\gamma_G), S) > g^e(\gamma^e; \gamma_G)$, then we have

$$Pr^*(\text{“link-removal”}) > \underbrace{F(\gamma_G) + (1 - F(\gamma_G))p_2 g^e(\gamma^e; \gamma_G)}_{(*)}.$$

If $\gamma_G > \gamma^e$, then $g^e(\gamma^e;\gamma_G) = 0$ by (12); thus $(*)$ becomes $F(\gamma_G)$, which is strictly greater than $F(\gamma^e) \equiv Pr^e(\text{"link-removal"})$ because $\gamma_G > \gamma^e$. Therefore, $Pr^e(\text{"link-removal"}) < Pr^*(\text{"link-removal"})$. If $\gamma_G \leq \gamma^e$, then $g^e(\gamma^e;\gamma_G) = \frac{F(\gamma^e)-F(\gamma_G)}{1-F(\gamma_G)}$ by (12); thus $(*)$ becomes $[F(\gamma_G) - F(\gamma^e)](1 - p_2) + F(\gamma^e)$, which equals to $F(\gamma^e) \equiv Pr^e(\text{"link-removal"})$ because $p_2 = 1$. Therefore, $Pr^e(\text{"link-removal"}) < Pr^*(\text{"link-removal"})$ if $g(h, \tilde{\gamma}(\gamma_G), S) > g^e(\gamma^e;\gamma_G)$. □

Proofs of Corollary 1. The proof follows directly from Propositions 3 and 4. □

For Online Publication

Online Appendices for

The Economics of the Right to be Forgotten

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B An Example

In this appendix, we present a simple example that illustrates the equilibrium characterizations and comparative statics results in Sections 2 and 4. In particular, to keep the analysis tractable for the RTBF game that is specified in Section 2, we assume that $F(\gamma)$ is a uniform distribution over the interval $[0, \bar{\gamma}]$ and $g(h, \gamma, S) = \frac{h}{h+\gamma S+S}$. The P's winning probability increases with h, other things being equal, but decreases with γ, S, or both. In our model the total social welfare loss (less fixed costs) is $\gamma S + S$ if the links are removed and h otherwise; thus, the above functional form of g captures the essential aspect of the expected court ruling that would depend on the relative balance between social welfare gain and loss that arise when one party wins.

For any given h, C_P, and C_G, Conditions 1 and 2 imply an upper bound and a lower bound on S, respectively. The upper bound, $\bar{S}$, ensures $\gamma^* > 0$; and the lower bound, $\underline{S}$, ensures $\gamma_G < \bar{\gamma}$ for any $p_2 > 0$. We let S^* to be the value of S such that $\gamma_G^* = \gamma^*$ given other parameter values. Lastly, the condition (7) implies an upper bound on c for P's claim to be profitable; so we denote $\bar{\bar{c}}$ as the upper bound when $S \in (\underline{S}, S^*)$ and $\bar{c}$ as the upper bound when $S \in [S^*, \bar{S})$. Both bounds on c depend on the given values of S and other parameters.

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Then we describe the unique sequential equilibrium of the RTBF game for all possible values of S as follows:

Corollary B.1. *For any given c, h, C_P, and C_G; there is a unique sequential equilibrium of the RTBF game, in which the equilibrium strategies are characterized as follows:*

(i) If $S \leq \underline{S}$, then $p_1 = 1$ if $c \leq h$ and $p_1 = 0$ if otherwise; all Gs accept; and $p_2 = 1$.

(ii) If $S \in (\underline{S}, S^*)$, then $p_1 = 1$ if $c \leq \bar{\bar{c}}$ and $p_1 = 0$ if otherwise; Gs of type $\gamma < \gamma_G^*$ accept and all others reject; and $p_2 = 1$.

(iii) If $S \in [S^*, \bar{S})$, then $p_1 = 1$ if $c \leq \bar{c}$ and $p_1 = 0$ if otherwise; Gs of type $\gamma < \gamma^*$ accept and all others reject; and $p_2 \in (0, 1]$.

(iv) If $S \geq \bar{S}$, then $p_1 = 0$; all Gs reject; and $p_2 = 0$.

Proof. The case *(i)* corresponds to when Condition 2 does not hold, that is, $\gamma_G^* \geq \bar{\gamma}$. In other words, all Gs will accept the claim if they believe that P will litigate with probability one. Because $\gamma_G^* < \gamma^*$, P prefers litigating over giving up regardless of his posterior expectation of γ at rejection, which in turn justifies G's acceptance no matter what her γ is. These strategies of G and P constitute the only subgame-perfect Nash equilibrium in the subgame after P's claim. Given this unique subgame equilibrium, the condition (7) becomes $c \leq h$ because $p_2 = 1$ and $\gamma_G = \bar{\gamma}$. Then P claims if $c \leq h$ and gives up if $c > h$. The proofs for cases *(ii)* and *(iii)* follow directly from Propositions 1 and 2. The case *(iv)* corresponds to when Condition 1 does not hold. In such case, P prefers giving up over litigating if all Gs reject (that is, if $\gamma_G = 0$). Then because P's posterior expectation of γ increases as more types of G accept (that is, as γ_G increases), his expected probability of winning in court decreases; and litigation becomes even less profitable to P. Hence, P chooses to give up at rejection regardless of his posterior expectations of γ; then given $p_2 = 0$, all Gs reject. Using backward induction, P chooses not to claim because $-h > -h - c$. These strategies of G and P constitute the unique sequential equilibrium of the RTBF game when $S \geq \bar{S}$. □

Because the lawsuits and the link removals can occur as equilibrium outcomes only if the claim is made, we assume that c is small enough so that the unique sequential equilibrium that is characterized in Corollary B.1 entails $p_1 = 1$ in all of the cases *(i)* through *(iii)*. In particular, we assume that $c \leq \bar{c}$ at $S = \bar{S}$. This assumption allows us to compute the maximal probability of lawsuits and of link-removal that could possibly be achieved for the range of S where $p_1 = 1$ can be part of the equilibrium strategy.

If $S < \bar{S}$, then the probability of lawsuits in the claim equilibrium is given by

$$Pr(\text{“lawsuits”}) \equiv Pr(\text{G rejects}) \cdot Pr(\text{P litigates}) = (1 - F(\gamma_G)) \cdot p_2,$$

where $Pr(\text{G rejects}) = 1 - F(\gamma_G)$ is the prior probability that G will reject the claim and $Pr(\text{P litigates}) = p_2$ is the probability that P litigates at rejection. If $S \geq \bar{S}$, then the equilibrium probability of lawsuits is simply zero because P does not claim in the first place; the strategies of “all Gs reject and P gives up” constitute the unique equilibrium in the subgame following a claim but this is a zero-probability event in the sequential equilibrium.

Figure B.1 illustrates the effect of an increase in S on $Pr(\text{“lawsuits”})$ as well as on $Pr(\text{G rejects})$ and $Pr(\text{P litigates})$, for the fixed values of $h = 50$ and $C_P = C_G = 10$ with a uniform distribution $F(\cdot)$ on $[0, 1]$. In the example of such primitives, the figure is valid as long as $c \leq 4.8$, which is only a sufficient condition for $p_1 = 1$ to be part of the equilibrium strategies for all $S < \bar{S}$.

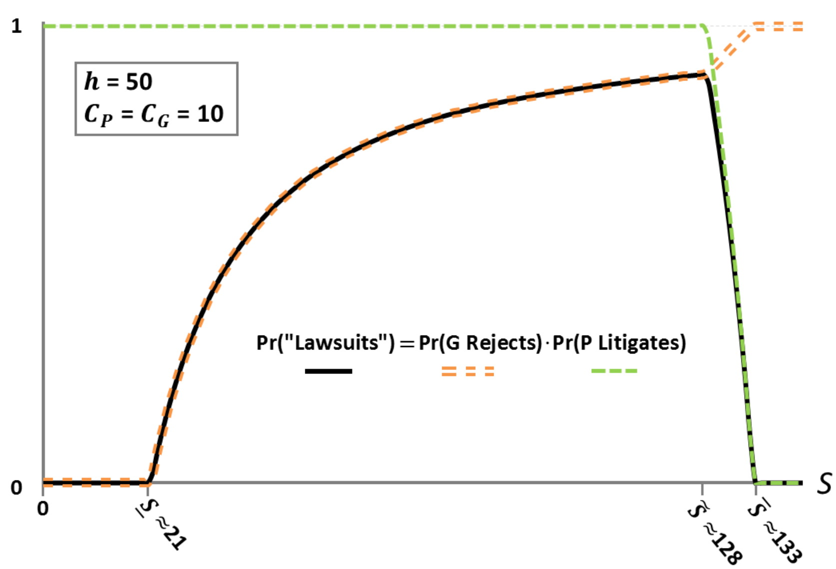


Figure B.1: The effect of S on the probability of lawsuits in equilibrium for small c

In this example, Condition 2 implies the lower bound on S, $\underline{S} \approx 21$, that ensures some positive probability of G's rejection; and Condition 1 implies the upper bound on S, $\bar{S} \approx 133$, that guarantees the possibility of P's litigating. The figure shows that the probability of lawsuits achieves its maximum at $\tilde{S} = S^* \approx 128$. When $S \leq \underline{S} \approx 21$, the probability of lawsuits in the claim equilibrium is zero because all Gs accept a claim if made. When $S \in (21, 128)$, the probability of lawsuits increases with S because more Gs reject and P maintains his strategy of litigating with probability one. An interesting observation in this range of S is that even when P's harm is relatively small compared to the search engine users' loss (e.g., $h = 50$ and $S = 100$), a higher users' loss and the corresponding lower expected probability of P winning in court do not deter P from acting aggressively. But when $S \in [128, 133)$, more Gs reject by an increase in S as before while P litigates less often; and this fall in P's probability of litigating contributes to a decrease in the probability of lawsuits. When $S \geq 133$, the probability of lawsuits is zero because P does not claim in the unique sequential equilibrium.

We also illustrate the effect of an increase in S on the equilibrium probability of link-removal. If $S < \bar{S}$, then the probability of link-removal in the claim equilibrium is given by

$$\begin{aligned} Pr(\text{“link-removal”}) &\equiv Pr(\text{G accepts}) + Pr(\text{“lawsuits”}) \cdot [\text{P's updated } \beta] \\ &= F(\gamma_G) + (1 - F(\gamma_G)) \cdot p_2 \cdot g(h, \tilde{\gamma}(\gamma_G), S), \end{aligned}$$

where $Pr(\text{G accepts}) = F(\gamma_G)$ is the prior probability that G will accept the claim and $[\text{P's updated } \beta] = g(h, \tilde{\gamma}(\gamma_G), S)$ is P's posterior assessed probability of winning in a trial. If $S \geq \bar{S}$, then the equilibrium probability of link-removal is zero because P does not claim in the unique sequential equilibrium of this game.

Figure B.2 shows the comparative statics on the equilibrium probability of link-removal and other relevant probability measures. The explanations for the results continue from the previous discussion on the probability of lawsuits. For any $S \leq 21$, the probability of link-removal equals to one because all Gs accept the claim and the probability of lawsuits is zero in the claim equilibrium. When $S \in (21, 133)$, the probability of link-removal decreases as S increases with a kink at $S = 128$. We detail the reasoning behind this result in Section 4. The main intuition is that a lower probability of G's acceptance of the claim is a dominating force

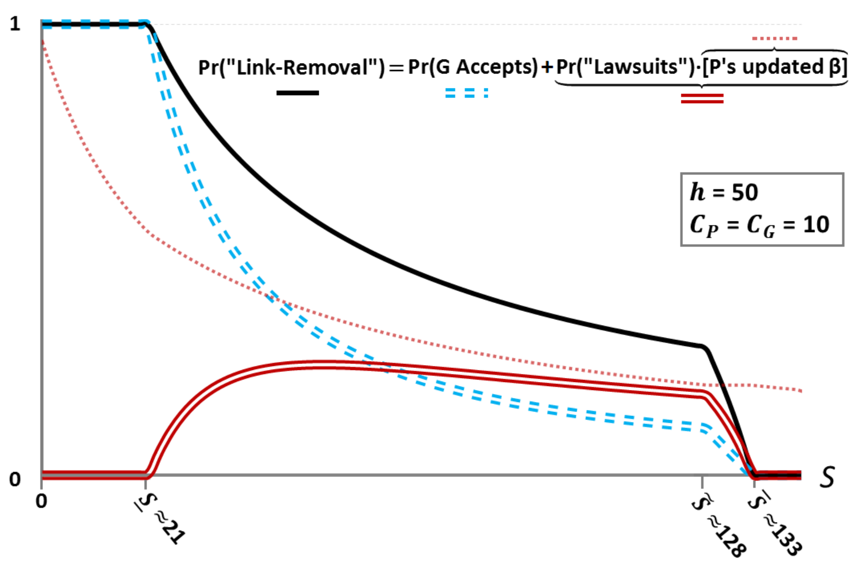


Figure B.2: The effect of S on the probability of link-removal in equilibrium for small c

that contributes to a lower chance of link-removal. Lastly for any $S \geq 133$, the probability of link-removal equals zero because P never claims in equilibrium.

C Comparative Statics on Litigation Costs

Because our RTBF game is featured as a legal dispute, G's decision to reject and P's decision to litigate are shaped by various factors including the magnitude of litigation costs. As a complementary analysis to Section 4, we discuss the effect of changes in litigation costs on the probability of lawsuits and the probability of link-removal in equilibrium.

We let $\bar{C}_P$ denote the upper bound on C_P implied by Condition 1 given other parameter values, and $\bar{C}_G$ denote the upper bound on C_G implied by Condition 2 given other parameter values. Also we denote C_P^* and C_G^* as the values of C_P and C_G respectively 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 hold for marginal changes in the parameters within the relevant range. The following lemma concerns how the best responses vary with litigation costs:

Lemma C.1. *An increase in P's litigation cost, C_P, has no effect on γ_G^* but decreases γ^*.*

An increase in G's litigation cost, C_G, increases γ_G^* but has no effect on γ^*. Formally:

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

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

First, we find the conventional result that the probability of lawsuits falls as G's litigation cost increases.[1] This is straightforward because, for any type, G's expected payoff from litigation becomes smaller with a higher litigation cost. Further, an increase in G's litigation cost (up to a certain point) causes more Gs to accept P's claim, creating a greater chance of link-removal. An increased probability of G's acceptance makes P's inference about the case less favorable to him at 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 litigate with a lower probability, which induces exactly the same interval of Gs who reject; but P's now lower probability of litigating leads to less chance of link removal.

Proposition C.1. *The probability of lawsuits decreases with C_G for any $C_G \in (0, \bar{C}_G)$. The probability of link-removal increases with C_G if $C_G \in (0, C_G^*)$, but decreases with C_G if $C_G \in [C_G^*, \bar{C}_G)$.*

Proof. Lemma C.1 implies that when $\gamma_G^* < \gamma^*$, G's optimal cutoff type $\gamma_G = \gamma_G^*$ increases with an increase in G's litigation cost C_G. Therefore, $Pr(\text{"lawsuits"}) = (1 - F(\gamma_G^*))$ falls with a small increase in C_G when $\gamma_G^* < \gamma^*$. On the other hand, when $\gamma^* \geq \gamma_G^*$, G's optimal cutoff type $\gamma_G = \gamma^*$ is not affected by a change in C_G. Regardless, $Pr(\text{"lawsuits"}) = (1 - F(\gamma^*))p_2$ falls with an increase in C_G because $p_2 = \frac{\gamma^* S}{g(h, \gamma^*, S)\gamma^* S + C_G}$ decreases with 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

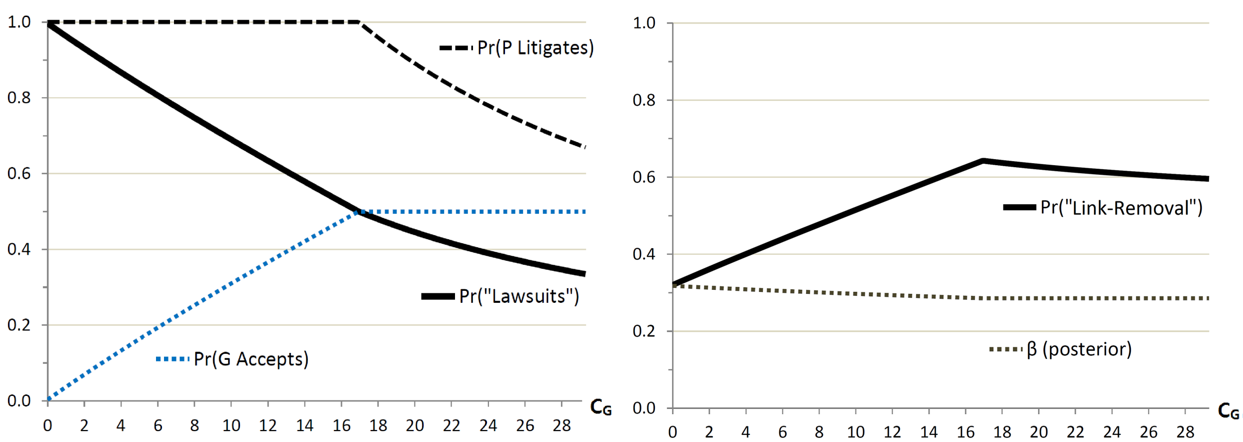
[1] Bebchuk (1984) shows that "an increase in the litigation costs of *either* party will increase the likelihood of a settlement" (409). The counterpart of the likelihood of a settlement translated into our setting is $1 - Pr(\text{"lawsuits"})$.

probability of link-removal, when $\gamma_G^* < \gamma^*$, it is given by $Pr(\text{“link-removal”}) = F(\gamma_G^*) + (1 - F(\gamma_G^*))g(h, \tilde{\gamma}(\gamma_G^*), S)$. As C_G increases, more Gs accept (that is, the first term increases). At the same time, the probability of lawsuits, $(1 - F(\gamma_G^*))$, and P's posterior assessed probability of winning in court, $g(h, \tilde{\gamma}(\gamma_G^*), S)$, both fall; so the multiplication of these two terms falls (that is, 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:

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

where the strict inequality holds because $g(h, \tilde{\gamma}(\gamma_G^*), S) > g(h, \tilde{\gamma}(\gamma_G^* + \varepsilon), S)$. This inequality gives a contradiction because $g(h, \tilde{\gamma}(\gamma_G^*), S)) < 1$. Now when $\gamma_G^* \geq \gamma^*$, the probability of link-removal is given by $Pr(\text{“link-removal”}) = F(\gamma^*) + (1 - F(\gamma^*))p_2 g(h, \tilde{\gamma}(\gamma^*), S)$. An increase in C_G does not affect the interval Gs who accept. This lack of effect implies that P's posterior assessed probability of winning remains the same; however a higher C_G lowers P's probability of litigating, and thus the probability of link-removal falls. □

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



(a) Probability of lawsuits (b) Probability of link-removal

Figure C.1: Comparative statics of C_G

In this example, we use $h = 35$ unlike the example with $h = 50$ in the subsequent analysis of the comparative statics of C_P. The reason that we use $h = 35$ here is for an illustrative purpose. If the given values are $h = 50$, $S = 50$, and $C_P = 10$, then it is always the case that $\gamma^*(= 5) > 1$, which implies that $\gamma^*_G < \gamma^*$ for any $C_G \in (0, \bar{C}_G)$. Hence, the probability of lawsuits falls without a kink and the probability of link-removal monotonically increases with an increases in C_G merely because more Gs accept. These observations imply that the comparative statics with regard to C_G crucially depend on the constant level of γ^* for given values of h, S, and C_P. For the case of $\gamma^*_G \geq \gamma^*$ to occur, we must require $\gamma^* < 1$, which would hold for a small enough h, a large enough S, and/or a high enough C_P.

One might expect that when the petitioner proceeds to court less often because of a higher litigation cost, this scenario would lead to a lower chance of the link removal. However, we show this is not always the case. A change in P's litigation costs has no effect on G's cutoff type (Lemma C.1) up to a certain level of C_P. Consequently, the probability of lawsuits and the probability of link-removal remain constant. The reasoning is that the probability of Gs rejection is high enough (when $\gamma^*_G < \gamma^*$)—enough to compensate for the P's higher cost—that P believes that he still has a fair chance of winning in court and litigates with probability one. However when C_P is relatively very high, P must proceed to court less often to induce more Gs to reject. Less Gs accept and those who reject are faced with a lower probability of P's litigating, both of which lead to a decrease in the probability of link-removal.

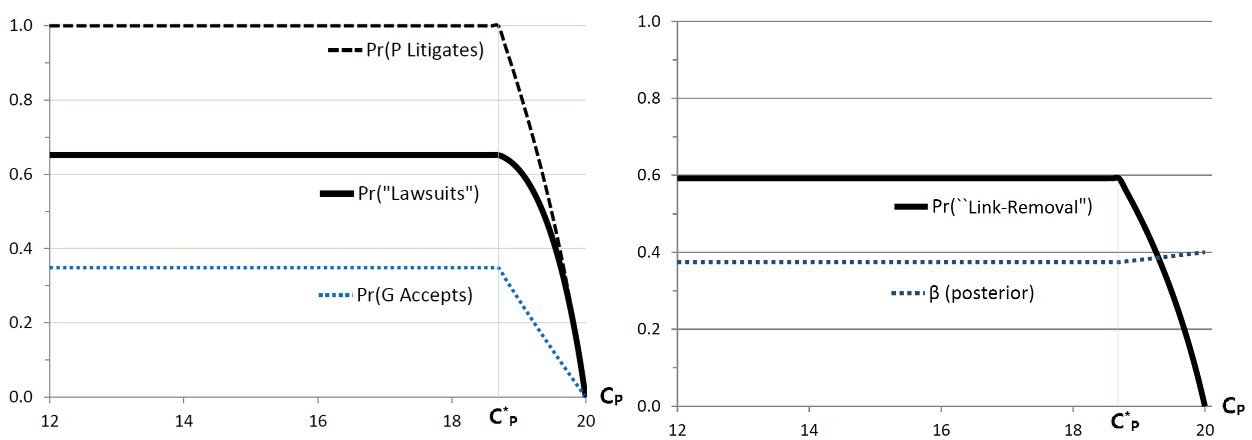
Proposition C.2. *The probability of lawsuits and the probability of link-removal both are not affected by a change in C_P if $C_P \in (0, C^*_P)$, but both decrease with C_P if $C \in [C^*_P, \bar{C}_P)$.*

Proof. Lemma C.1 implies that when $\gamma^*_G < \gamma^*$, γ^*_G is not affected by C_P. Then $Pr(\text{“lawsuits”}) = (1 - F(\gamma^*_G))$ remains constant by any small change in C_P when $\gamma^*_G < \gamma^*$. Moreover, because γ^*_G does not change, both the probability of G's rejection (and obviously the probability of acceptance) and P's posterior assessed winning probability stay the same. Thus $Pr(\text{“link-removal”}) = F(\gamma^*_G) + (1 - F(\gamma^*_G))g(h, \tilde{\gamma}(\gamma^*_G), S)$ 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 the indirect effect of C_P on $Pr(\text{“lawsuits”})$ through γ^*. For $C_P \in [C^*_P, \bar{C}_P)$ (or when $\gamma_G^* \geq \gamma^*$), we have:

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

where the first term is positive because $\frac{d\gamma^*}{dC_P} < 0$ by Lemma C.1, whereas the second term is negative because $\frac{\partial p_2}{\partial \gamma^*} > 0$. Further, 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 (C.1) remains negative for $C_P \in (C_P^*, \bar{C}_P)$ assuming $\frac{f(\gamma)}{1-F(\gamma)}$ strictly increases with γ. Therefore, $Pr(\text{“lawsuits”}) = (1-F(\gamma^*))p_2$ decreases with C_P when $\gamma_G^* \geq \gamma^*$. For the probability of link-removal in this case, we have $Pr(\text{“link-removal”}) = F(\gamma^*) + (1 - F(\gamma^*))p_2 g(h, \tilde{\gamma}(\gamma^*), S)$, 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 probability of link-removal also decreases with C_P when $\gamma_G^* \geq \gamma^*$. □

Figure C.2 illustrates the effect of an increase in C_P for the fixed values of $h = 50$, $S = 50$, and $C_G = 10$ with a uniform distribution $F(\cdot)$ on $[0, 1]$ and $g(h, \gamma, S) = \frac{h}{h+\gamma S+S}$.



(a) Probability of lawsuits (b) Probability of link-removal

Figure C.2: Comparative statics of C_P

D Alternative Information Structures

Our RTBF game adopts a particular information structure that the petitioner's harm h is public knowledge while the search engine's γ is private information. We find it worthwhile discussing alternative information structures.

In a complete information game, two kinds of sequential equilibria arise. In one kind, when the petitioner knows that the search engine will accept the claim, he will claim if the claim fee is small enough. In the other kind, when the petitioner knows that the search engine will reject the claim, he will claim only when his commitment to litigating is credible. If so, however, the petitioner's claim becomes a mere cost with no benefit: why should a petitioner pay the claim fee when he already knows that the search engine will reject and his litigating is sequentially rational? Thus this complete information benchmark is useful in making clear what incomplete information adds to the analysis.

Consider now a situation in which the petitioner is the party who has private information. That is, the petitioner knows h and the search engine only knows its distribution from which h is drawn. But if the petitioner with private information is the first-mover in the game, then the search engine's inference that claiming is associated with larger harm strengthens the petitioner's position in making a credible threat to litigate. In fact, if the petitioner has superior information, then why would he bother to go through the claim process if he expects the search engine's rejection and has a better assessment of the trial's expected outcome? While our model can be easily adjusted to apply to the case in which the petitioner is the one with private information, we find that such case does not yield interesting implications to the current issue of the RTBF.

Lastly, one may consider the RTBF game in which the search engine is also uncertain about the magnitude of the petitioner's harm in addition to the petitioner's uncertainty about the search engine's loss. When uncertainty is two-sided, we need to consider the search engine's inference problem regarding the petitioner's harm level because the petitioner also has signaling incentives about his private information. The extent of signaling incentives will be greater for a higher claim fee. But we expect the claim fee to be small given that the current removal request process is quite simple. Although a model with two-sided incomplete information is an interesting theoretical object, the equilibrium characterizations are similar as in Propositions 1 and 2.[2] Further, the petitioner's signaling about private harm does not appear to be an issue of significance in the ongoing debate of the RTBF, as Google does not make settlements with individual petitioners. Because we do not lose any important economic insight by assuming away the search engine's uncertainty about the petitioner's harm, we espouse the game with one-sided incomplete information in which the petitioner's uncertainty about the search engine's response plays an essential role. In addition, our information structure is consistent with the models of Bebchuk (1984) and of Nalebuff (1987) where the defendant has private information, which reflects a tort case in which the defendant knows better about her negligence. Another advantage of our setup is its consistency with the current US treatment of a privacy invasion under tort law.

E Different Legal Rules on Litigation Costs

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

First, we notice that the payoffs that depend upon the court ruling are larger under the British rule than under the American rule. Specifically, the below table shows the petitioner's payoffs for each possible outcome of a trial under the two cost rules:

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

The petitioner's marginal benefit from litigating against G of a low type 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 P's litigation cost C_P under

[2]See Daughety and Reinganum (2014) for a comprehensive survey on pretrial negotiation and litigation games with various information structures.

the American rule occurs regardless of a trial's outcome, whereas under the British rule P bears no litigation cost if he wins but $(C_P + C_G)$ if he loses. This implies that for P's best response, a change to the British rule lowers the cutoff value of G's type, γ^*, that makes P indifferent between litigating and giving up at rejection.

Now G's payoffs for each possible outcome of a trial under the two cost rules are shown below.

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

How would the British rule affect G's optimal strategy? We find that G's cutoff type γ_G might rise or fall depending on the size of the litigation costs. To understand this result, we let γ_G^A and γ_G^B denote the cutoff types who are indifferent between accepting or rejecting under the American rule and British rule respectively. We find that the values 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, then the cutoff type γ_G^A who is indifferent between accepting or 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 Gs reject under the British rule than under the American rule. In this regard, the "chilling effect" can be a 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 against P's strategy under the same primitives.

Taking into account the above effects of a change in the litigation cost rules on the equilibrium strategies of P and G, we arrive at the following result.

Proposition E.1. *A change from the American rule to the British rule might increase, decrease, or have no effect on the probability of lawsuits and the probability of link-removal, depending on the primitives of the model.*

Proof. Given the primitives that satisfy Conditions 1 and 2 under both rules, the discussion in the text shows that γ^* is lower under the British rule than under the American rule. Because the probability of lawsuits and the probability of link-removal depend on γ_G^* and whether $\gamma_G^* < \gamma^*$ or $\gamma_G^* \geq \gamma^*$ given other parameters, we focus on showing that the effect on γ_G^* of changing from the American rule to the British rule is ambiguous. First, γ_G^* under the American rule, here denoted as γ^A, satisfies

$$\gamma^A S = g(h, \gamma^A, S)\gamma^A S + C_G, \tag{E.1}$$

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

$$\gamma^B S = g(h, \gamma^B, S)(\gamma^B S + C_G + C_P). \tag{E.2}$$

If G of the cutoff type γ^A under the American rule compares 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 the values of h, S, C_P, and C_G whether

$$\begin{aligned} g(h, \gamma^A, S)\gamma^A S + C_G &\lesseqqgtr g(h, \gamma^A, S)(\gamma^A S + C_G + C_P), \\ \leftrightarrow (1 - g(h, \gamma^A, S))C_G &\lesseqqgtr g(h, \gamma^A, S)C_P. \end{aligned} \tag{E.3}$$

If (E.3) holds with inequality ($<$), then $\gamma^B > \gamma^A$; if ($>$), then $\gamma^B < \gamma^A$; and if ($=$), then $\gamma^B = \gamma^A$. The intercept of the RHS of (E.2) when $\gamma^B = 0$ is $g(h, 0, S)(C_G + C_P)$, and the intercept of the RHS of (E.1) when $\gamma^A = 0$ is C_G. Therefore, when the values of h, S, C_P, and C_G are such that $g(h, 0, S)(C_G + C_P) \leq C_G$, then $\gamma^B < \gamma^A$. This is because $g_\gamma < 0$ and thus the slope of the RHS of (E.2), $g_\gamma(\gamma S + C_G + C_P) + gS$, is strictly less than the slope of the RHS of (E.1), $g_\gamma \gamma S + gS$. On the other hand, when $g(h, 0, S)(C_G + C_P) > C_G$, then it crucially depends on (E.3). Thus it follows that the probability of lawsuits and the probability of link-removal can either rise, fall, or remain the same. The effect depends on the given parameter values, whether $\gamma^B > \gamma^A$, and whether $\gamma^B > \gamma^*$. □

Nonetheless, the equilibria of the RTBF game under the British rule can be characterized similarly as in Propositions 1 and 2. Further, all of the key insights of our equilibrium and efficiency analyses remain intact under the British rule.

F Equilibrium under the Social-Optimal Rule

In this appendix, we analyze the equilibria of the original RTBF game but with the additional assumption that the outcome of a trial is determined by the social planner's decision rule that maximizes the ex-post social welfare. We refer to this game as a *RTBF game under the social-optimal rule.*

In the RTBF game under the social-optimal rule, the players are knowledgeable of the fact that the outcome of a trial exactly follows the social planner's welfare maximizing decision rule. That is, we consider the situation where the court is capable of gathering all of the relevant factual issues and rules efficiently. Then in this game, the likelihood of P prevailing in a trial, β^e, is characterized as follows:

$$\beta^e \equiv \begin{cases} 1 & \text{if } \gamma \leq \gamma^e, \\ 0 & \text{if } \gamma > \gamma^e, \end{cases} \tag{F.1}$$

where γ^e is the social planner's efficiency cutoff that is defined in (10). We assume that this function is publicly known to both P and G. Then G estimates the likelihood of P winning in a trial to be β^e on the basis of her private information γ. However, P does not know γ but only knows its distribution $F(\cdot)$ over $[0, \bar{\gamma}]$. Therefore, P's ex-ante expected probability of winning at trial is:

$$\mathbb{E}[\beta^e] = \begin{cases} 1 & \text{if } \bar{\gamma} \leq \frac{h-S}{S}, \\ F\left(\frac{h-S}{S}\right) \cdot 1 + \left(1 - F\left(\frac{h-S}{S}\right)\right) \cdot 0 & \text{if } 0 < \frac{h-S}{S} < \bar{\gamma}, \\ 0 & \text{if } \frac{h-S}{S} \leq 0. \end{cases} \tag{F.2}$$

As in Subsection 2.3, (p_1, p_2) represents P's strategy. After P's claim, G anticipates that P will behave according to p_2. In the subgame following P's claim, G of type γ compares the payoff from accepting, $-\gamma S$, with the expected payoff from rejecting, $p_2[-\beta^e \gamma S - C_G]$, which equals $p_2[-C_G]$ if $\gamma > \gamma^e$ and $p_2[-\gamma S - C_G]$ if $\gamma \leq \gamma^e$. Again, G uses a cutoff strategy with the cutoff type γ_G^e that is defined as the type of G who is indifferent to accepting or rejecting the claim given p_2. After the claim has been rejected, P must compare his payoff from giving up, $-h-c$, with that from litigation,

$$-(1-\mathbb{E}[\beta^e|\gamma \geq \gamma_G^e])h - c - C_P, \tag{F.3}$$

where P's posterior expectation of winning probability is given by

$$\mathbb{E}[\beta^e|\gamma \geq \gamma_G^e] = \begin{cases} 1 & \text{if } \bar{\gamma} \leq \frac{h-S}{S}, \\ \frac{F\left(\frac{h-S}{S}\right)-F(\gamma_G^e)}{1-F(\gamma_G^e)} & \text{if } 0 < \gamma_G^e \leq \frac{h-S}{S} < \bar{\gamma}, \\ 0 & \text{if } 0 < \frac{h-S}{S} < \gamma_G^e < \bar{\gamma}, \\ 0 & \text{if } \frac{h-S}{S} \leq 0. \end{cases} \tag{F.4}$$

If $\gamma^e \in (0,1)$, then there is a non-empty proper subset of G's types against whom the social planner dictates the link removal for any given h and S. The following condition ensures that when $\gamma^e \in (0,1)$ the petitioner prefers litigating over giving up given the prior distribution of G's types, that is, $F\left(\frac{h-S}{S}\right) h \geq C_P$.

Condition F.1. $\bar{\gamma}S + S > C_P$.

If the converse holds, then there is no equilibrium other than the one in which P never claims when $h < \bar{\gamma}S + S$. In theory, this is not an issue because it just implies that the unique sequential equilibrium of the RTBF game for the case of $h < \bar{\gamma}S + S$ is a no-claim equilibrium. Further, when $h \geq \bar{\gamma}S + S$ and $h \geq C_P$, there is a unique equilibrium in which P claims as long as $h > c$. But again if $h \geq C_P$ is not guaranteed, then for any given c, h, S, C_P, and C_G; the only sequential equilibrium in this RTBF game is such that P never claims. So our game is of no interest in the sense that its equilibrium predicts that P does not claim or G always accepts a claim if made. These predictions do not adequately describe Europe's current situation over the RTBF that Google receives a considerable amount of removal requests and rejects over 50 percent of those requests. In this sense, Condition F.1 allows us to focus on the RTBF game that yields non-trivial equilibrium predictions.

If the parameters are such that $S < h < \bar{\gamma}S + S$, then we define $h^* \in (S, \bar{\gamma}S + S)$ to be a unique value that solves $F\left(\frac{h^*-S}{S}\right) h^* = C_P$ for the given S and C_P; and γ^{**} to be a unique value that solves $\frac{F\left(\frac{h-S}{S}\right)-F(\gamma^{**})}{1-F(\gamma^{**})}h = C_P$. The γ^{**} is the cutoff type of G that makes P indifferent between litigating and giving up after rejection by Gs of type $\gamma \geq \gamma^{**}$. We then characterize the unique sequential equilibrium in this game as follows.

Proposition F.1. *Under Condition F.1, for any given c, h, S, C_P, and C_G; there is a unique sequential equilibrium of the RTBF game under the social-optimal rule that is characterized as follows:*

(i) If $h \leq S$, then $p_1 = 0$, $p_2 = 0$, and all Gs reject.

(ii) If $S < h < h^*$, then $p_1 = 0$, $p_2 = 0$, and all Gs reject.

(iii) If $h^* \leq h < \bar{\gamma}S + S$, then $p_1 = 1$ if $c \leq F(\gamma^{**})h$, $p_2 = \frac{\gamma^{**}S}{\gamma^{**}S+C_G}$, and only Gs of type $\gamma \geq \gamma^{**}$ reject where γ^{**} satisfies $F(\gamma^{**}) = \frac{F\left(\frac{h-S}{S}\right)h-C_P}{h-C_P}$.

(iv) If $h \geq \bar{\gamma}S + S$, then $p_1 = 1$ if $c \leq h$, $p_2 = 1$, and all Gs accept.

Proof. We proceed the proof by cases in the proposition.

For case *(i)*: $\frac{h-S}{S} \leq 0$ (or $h \leq S$). If the parameters of the model are such that $h \leq S$, then the social-optimal rule calls for P to always lose in a trial (because $\gamma^e = 0$); and both P and G know this. That is, G estimates the likelihood of P winning in a trial to be $\beta^e = 0$, and at rejection P's posterior expectation of winning is identical to the prior expectation, that is, $\mathbb{E}[\beta^e|\gamma \geq \gamma^e_G] = \mathbb{E}[\beta^e] = 0$ regardless of which types of G reject. Then the game tree depicted in Figure 1 changes so that the expected payoffs from litigation are $-h - c - C_P$ for P and $-C_G$ for G. Therefore, G's private information does not play any role in the game. Thus, there is a unique sequential equilibrium in which P never claims, G always rejects, and P always gives up.

For cases *(ii)* and *(iii)*: $0 < \frac{h-S}{S} < \bar{\gamma}$ (or $S < h < \bar{\gamma}S + S$). In this case, the social planner's efficiency cutoff is $\gamma^e = \frac{h-S}{S}$. Thus the social-optimal rule is

$$\beta^e = \begin{cases} 1 & \text{if } \gamma \leq \frac{h-S}{S}, \\ 0 & \text{if } \gamma > \frac{h-S}{S}. \end{cases}$$

Then any G will correctly assess the likelihood of P winning in a trial to be the above β^e. The petitioner's expected winning probability at trial under the prior distribution of G is $\mathbb{E}[\beta^e] = F\left(\frac{h-S}{S}\right)$; that is, upon rejection, P expects that he will definitely win if Gs of type $\gamma \leq \frac{h-S}{S}$ reject and that he will definitely lose if Gs of type $\gamma > \frac{h-S}{S}$ reject. In the subgame following P's claim, suppose that all types of G reject, that is, $\gamma_G^e = 0$. Then after the claim has been rejected, P must compare his payoff from giving up, $-h-c$, with that from litigation, $-(1-\mathbb{E}[\beta^e|\gamma \geq 0])h - c - C_P$, which equals $-\left(1 - F\left(\frac{h-S}{S}\right)\right)h - c - C_P$. (Refer to (F.2) and (F.4).)

(ii) If $F\left(\frac{h-S}{S}\right)h < C_P$, then P will always prefers giving up over litigation, that is, $p_2 = 0$. If G believes that the probability of P's litigation is zero, then any type of G will reject. Thus after rejection P is correct to give up. Therefore, these strategies of P and G constitute a unique Nash equilibrium in the subgame when the claim is made. Consider now P's initial node in which he decides whether to claim or not. His no claim payoff is $-h$, whereas his expected payoff from a claim given the equilibrium strategies in the subgame Nash equilibrium is $-h-c$. Thus P's optimal strategy at his initial node is no claim, that is, $p_1 = 0$. Thus these strategies form a unique sequential equilibrium in the RTBF game under the social-optimal rule if $F\left(\frac{h-S}{S}\right) < C_P$.

(iii) If $F\left(\frac{h-S}{S}\right)h \geq C_P$, then P always prefers litigating over giving up, that is, $p_2 = 1$. If G believes that the probability of P's litigation is one, then Gs of type $\gamma \leq \frac{h-S}{S}$ (who expect $\beta^e = 1$) will accept the claim because $-\gamma S > -\gamma S - C_G$, whereas Gs of type $\gamma > \frac{h-S}{S}$ (who expect $\beta^e = 0$) will compare $-\gamma S$ with $-C_G$ and will reject if $\gamma > \frac{C_G}{S}$. Because only the types of G who expect to definitely win in a trial (and expect to gain in litigation) will reject if she believes that P will litigate with probability one, P's posterior expectation of winning probability must be zero at rejection by these types. This implies that P's threat to litigate with probability one is not credible, and thus it must be $p_2 < 1$. The petitioner wants to lower his probability of litigating so as to make more Gs reject (i.e., more types than the types $\gamma > \frac{h-S}{S}$). To induce some types of $\gamma \leq \frac{h-S}{S}$ to reject, the borderline type of G who is indifferent between accepting or

rejecting the claim γ_G^e must be below $\frac{h-S}{S}$ and must satisfy:

$$-\gamma_G^e S = p_2[-\gamma_G^e S - C_G],$$

given that G believes that the probability of P's litigation is $p_2 \in (0,1)$. Thus $\gamma_G^e = \frac{p_2 C_G}{(1-p_2)S}$. The G's best response against p_2 is then characterized such that Gs of type $\gamma \geq \gamma_G^e$ reject and Gs of type $\gamma < \gamma_G^e$ accept. Now after the claim is rejected, P's posterior expectation of winning probability is $\mathbb{E}[\beta^e|\gamma \geq \gamma_G^e] = \frac{F\left(\frac{h-S}{S}\right)-F(\gamma_G^e)}{1-F(\gamma_G^e)}$. The petitioner's strategy p_2 must be optimal given G's optimal cutoff strategy γ_G^e. Let γ^{**} be the unique value that solves:

$$\frac{F\left(\frac{h-S}{S}\right) - F(\gamma^{**})}{1 - F(\gamma^{**})} h = C_P. \tag{F.5}$$

The value γ^{**} exists as long as $F\left(\frac{h-S}{S}\right) \geq C_P$. This is the cutoff type of G that makes P indifferent between litigating and giving up after rejection by Gs of type $\gamma \geq \gamma^{**}$. So if G's cutoff type is $\gamma_G^e = \gamma^{**}$, P follows a randomized strategy $p_2 \in (0,1)$. In turn, P's strategy should confirm that G actually uses the cutoff γ^{**}; that is, p_2 must be:

$$p_2 = \frac{\gamma^{**} S}{\gamma^{**} S + C_G}.$$

If G believes that P randomizes between litigating and giving up with the probability given above, G's best response is to use the cutoff $\gamma_G^e = \gamma^{**}$. These strategies constitute the unique Nash equilibrium in the subgame when the claim is made. At P's initial node, P files a claim (under the prior distribution of G's types) given the subgame equilibrium strategies if $c \leq F(\gamma^{**})h$. Thus there is a unique sequential equilibrium in the RTBF game in which $p_1 = 1$ if $c \leq F(\gamma^{**})h$ and $p_2 = \frac{\gamma^{**} S}{\gamma^{**} S + C_G}$; and G uses a cutoff strategy with the cutoff γ^{**}, if $F\left(\frac{h-S}{S}\right) \geq C_P$.

Further, Condition F.1 ensures that when $S < h < \bar{\gamma} S + S$ there is a parametric region where $F\left(\frac{h-S}{S}\right) h \geq C_P$. To see this, suppose that $\bar{\gamma} S + S \leq C_P$ holds. Then it must always be $F\left(\frac{h-S}{S}\right) h < C_P$ because $F\left(\frac{h-S}{S}\right) h < F\left(\frac{h-S}{S}\right)(\bar{\gamma} S + S) < \bar{\gamma} S + S \leq C_P$. Without Condition F.1, there is no equilibrium other than the one in which P never claims when $h < \bar{\gamma} S + S$.

But Condition F.1 guarantees that there is a $\gamma^{**} < \frac{h-S}{S}$ such that (F.5) holds. Thus this condition entails that when $S < h < \bar{\gamma}S + S$, we can have the unique sequential equilibrium in which P litigates with positive probability if $h^* \leq h < \bar{\gamma}S + S$.

For case *(iv)*: $\bar{\gamma} \leq \frac{h-S}{S}$ (or $\bar{\gamma}S+S \leq h$). Lastly, if the parameters of the model are $h \geq \bar{\gamma}S+S$, then the social-optimal rule calls for P to always win at trial (because $\gamma^e = \bar{\gamma}$); and both P and G know this. That is, G estimates the likelihood of P winning in a trial to be $\beta^e = 1$, and upon rejection by some (or all) types of G, P's posterior expectation of winning is still identical to the prior expectation, that is, $\mathbb{E}[\beta^e|\gamma \geq \gamma^e_G] = 1$. Then the expected payoffs from litigation become $-c - C_P$ for P and $-\gamma S - C_G$ for G. As in case *(i)*, G's private information does not play any role in the game. If $C_P > h$, then the unique sequential equilibrium is that P never claims, all Gs reject, and P always gives up; if $C_P \leq h$, then the unique sequential equilibrium is that P claims if $h > c$, all Gs accept, and P always litigates with probability one at rejection. But Condition F.1 rules out the former case because $h \geq \bar{\gamma}S + S > C_P$. □

Henceforth, we assume that the claim fee is sufficiently small so that the claim is made where it can be part of the equilibrium strategy; that is, for cases *(iii)* and *(iv)*, we focus on the equilibrium with $p_1 = 1$. A necessary condition is $c \leq h$ because otherwise P does not claim in any unique sequential equilibrium that is characterized in Proposition F.1. This is a reasonable assumption given the fact that the potential petitioners face a small claim fee under the current process, whereas litigation can be costly.

Then we can compute the equilibrium probability of link-removal of the RTBF game under the social-optimal rule as follows:

$$Pr^{**}(\text{“link-removal”}) = \begin{cases} 1 & \text{if } h \geq \bar{\gamma}S + S, \\ F(\gamma^{**}) + \left[F\left(\frac{h-S}{S}\right) - F(\gamma^{**})\right]\frac{\gamma^{**}S}{\gamma^{**}S+C_G} & \text{if } h^* \leq h < \bar{\gamma}S + S, \\ 0 & \text{if } h < h^*, \end{cases} \tag{F.6}$$

where $h^* > S$ for given S. We can compare this equilibrium probability of link-removal under the social-optimal rule to the efficient probability of link-removal, Pr^e(“link-removal”), that is given by (11). We arrive at the following comparison.

Proposition F.2. *For any given parameter values (with $c \leq h$),*

$$Pr^{**}(\text{“}\textit{link-removal}\text{”}) = Pr^{e}(\text{“}\textit{link-removal}\text{”}) = 1 \qquad \textit{if } h \geq \bar{\gamma}S + S,$$
$$Pr^{**}(\text{“}\textit{link-removal}\text{”}) < Pr^{e}(\text{“}\textit{link-removal}\text{”}) \qquad \textit{if } S < h < \bar{\gamma}S + S,$$
$$Pr^{**}(\text{“}\textit{link-removal}\text{”}) = Pr^{e}(\text{“}\textit{link-removal}\text{”}) = 0 \qquad \textit{if } h \leq S.$$

Proof. First if $h \geq \bar{\gamma}S+S$, it trivially follows that $Pr^{**}(\text{“link-removal”}) = Pr^{e}(\text{“link-removal”})$ because both probabilities equal one. (See (11) and (F.6).) Second, if $S < h < \bar{\gamma}S + S$, then $Pr^{**}(\text{“link-removal”})$ is either zero (if $h < h^*$) or $F(\gamma^{**}) + \left[F\left(\frac{h-S}{S}\right) - F(\gamma^{**})\right]\frac{\gamma^{**}S}{\gamma^{**}S+C_G}$ (if $h^* \leq h < \bar{\gamma}S + S$). For the former case, $Pr^{**}(\text{“link-removal”}) = 0 < F\left(\frac{h-S}{S}\right) = Pr^{e}(\text{“link-removal”})$; for the latter case, $Pr^{**}(\text{“link-removal”}) < Pr^{e}(\text{“link-removal”})$ because $\gamma^{**} < \frac{h-S}{S}$ and $\frac{\gamma^{**}S}{\gamma^{**}S+C_G} \in (0, 1)$. Lastly, if $h \leq S$, both probabilities equal zero again by (11) and (F.6). □

Proposition F.2 asserts that even if the players play this game under the social welfare maximizing court ruling, a (weakly) lower chance of link-removal is expected than we would expect if the social planner controls everything. This result implies that even if the court ruling is socially optimal in the RTBF game, inefficiency (as represented by discrepancy between the two probabilities of link-removal) arises when $S < h < \bar{\gamma}S + S$. The source of this inefficiency is the presence of asymmetric information.

The reasoning can be explained as follows. When $S < h < h^*$, litigation is not profitable to P under the prior distribution of γ. Knowing this, even the low types of G can reject in expectation of P giving up, which in turn gives P no incentive to litigate at rejection. Thus P does not claim. When $h^* \leq h < \bar{\gamma}S + S$, litigation is profitable to P under the prior distribution of γ. Then only some of the high types of G that are sure of winning in a trial will reject, which in turn makes P lower his probability of litigating so as to induce some lower types of G to reject. These equilibrium behaviors are essentially due to the fact that the petitioner does not know the exact type of G he is facing. In particular, some low types of G can reject in expectation of P giving up even if such types are sure of losing in a trial if P does litigate. Even if P would have won the trial against those low types, he fears losing if he ends up facing a high type. Hence, P either does not even take a chance of making a claim or does not commit to litigation with probability one. These equilibrium strategies render a lower expected probability of link-removal in equilibrium. On the other hand, if the social planner chooses the outcome, we expect a higher chance of link-removal.

Figure F.1 illustrates Proposition F.2 in terms of S for the example that is given in online Appendix B. In the cases where the relative size of S against h is very small or very large, the equilibrium probability of link-removal under the social-optimal rule and the efficient probability of link-removal coincide. This equivalence implies that in the two extreme cases, the players in the RTBF game achieve social efficiency if the court ruling is socially optimal.

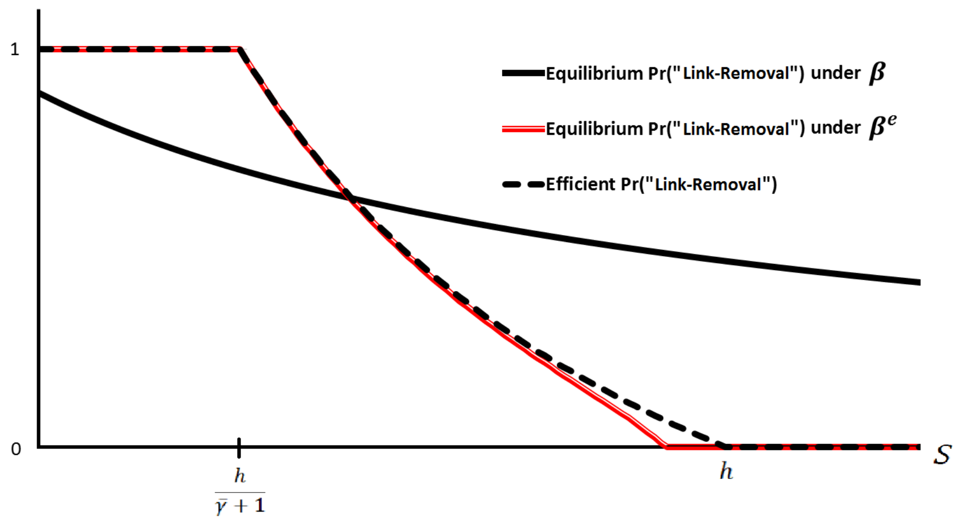


Figure F.1: Probability of link-removal

Lastly, we compare the equilibrium probability link-removal under the general $\beta = g(h, \gamma, S)$ to the equilibrium probability of link-removal under the social-optimal rule. This comparison permits us to isolate the inefficiency that originates in the way court decides. We can see from the above figure that, compared to our original game, the link removal under the social-optimal rule is more likely if S is relatively small and is less likely if otherwise, given other parameter values. In the original game, the expected ruling of a trial is an arbitrarily chosen policy function that imposes minimal assumptions on how the court might decide on its ruling. Regardless of whether there is a higher or lower chance of link removal, the difference between the two probabilities of link-removal represents inefficiency that arises from the court rule.

This result suggests a testable empirical prediction if we gather data on the outcomes of RTBF cases as well as the estimated values of h, S, and $\bar{\gamma}$ for each case. Then for any given pair (h, S), we can compute the likelihood of link-removal. If we observe that this likelihood is lower or greater than what we expect under the social-welfare maximizing court rule, then we could conclude that the current court ruling is away from the socially optimal one. The larger the difference, we can argue that the current court decision rule is possibly more inefficient.

G Threats to Reputation Capital

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

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

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

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

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

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

Then for any positive deletion of the blemished reputation ($\nu > 0$), an agent's posterior belief for the efficient professional with the clean reputation is lower than that under no deletion. That is, $P(E|U) > \widetilde{P}(E|U)$.

Remarkably, the changes in the clients' inference from the reputation system have not only a *static informational bias* but also—potentially more important—*adverse dynamics*. Suppose that the efficient professionals earn the payoff of V once he or she is matched to and works for the agent. If the posterior belief also indicates the matching probability (for simplicity), then the efficient earn $V \cdot P(E|U)$ with the links but only $V \cdot \widetilde{P}(E|U)$ with the removal of the links: the return to the clean reputation decreases when the blemished reputation is washed out. This decrease can lead to vicious dynamics in which the more professionals misbehave but later get washed out by the resets in turn weakens the incentives to have a good reputation. In this aspect, the parameter S in our RTBF game can broadly include any negative effects of the link removals on the system of reputation capital.[3] Thus, the social welfare loss associated with the right to be forgotten and its global expansion can be substantial when its negative impact on reputation systems is taken into account.

[3]As a related point, some argue that the global expansion of the European right to be forgotten might lead to more censorship by public officials such as autocrats who want to whitewash the past or remove links they do not like. See The Editorial Board. 2015. "Europe's Expanding 'Right to be Forgotten.'" *New York Times*, February 4, A24. http://www.nytimes.com/2015/02/04/opinion/europes-expanding-right-to-be-forgotten.html. Focusing on the economics of the right to be forgotten, we do not take such concerns into account throughout this paper.

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