Lost Profits and Unjust-Enrichment Damages for the Misappropriation of Trade Secrets

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ABSTRACT

This paper analyzes civil remedies for the misappropriation of trade secrets. We study the impact of different damages doctrines on firms' competitive behavior and on the incentives to misappropriate. We find that the owner of a trade secret is better off under the lost-profits regime, while the rival (independently of whether he obtained the technology by misappropriation or by independent development) is better off under the unjust-enrichment regime. The unjust-enrichment regime provides fewer incentives to misappropriate and yields a smaller market deadweight loss. The choice between the two rules essentially depends on the lawmaker's goal.

1. INTRODUCTION

In February 2020, a jury for the US District Court for the Northern District of Illinois awarded Motorola $764.6 million after determining that Hytera, a Chinese electronics manufacturer, had used Motorola's trade secrets in its products (*Motorola Solutions v. Hytera Communications Corp.*, 1:17-cv-01973 [N.D. Ill. August 6, 2021]). Motorola had sued Hytera claiming that the three engineers whom Hytera had hired away from its Malaysian office had stolen and brought with them thousands of confidential documents and that Hytera had used those documents,

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which contained trade secrets and lines of source code, to develop a state-of-the-art digital radio that was functionally indistinguishable from its own. Hytera had in turn sold those radios all around the world, including in the United States. The damages awarded, among the highest ever awarded for this type of claim, included $345.8 million in compensatory damages and $418.8 million in exemplary damages. Compensatory damages were calculated so as to disgorge all of Hytera's profits from the accused products from 2010 to 2019. While Hytera did not dispute that some proprietary information had been (illegally) transferred by the three engineers, it complained that Motorola had waited years after knowing about the theft to file a suit so as to profit from Hytera's business.[1]

This verdict is remarkable in two aspects. First, it highlights the sizeable dimension reached by litigation over trade secrets. Damages awarded for the misappropriation of trade secrets have increased since enactment of the Defend Trade Secrets Act of 2016 (DTSA; Pub. L. No. 114-153, 130 Stat. 376), which introduced a federal civil cause of action. As clarified in the *Motorola* decision, the DTSA also allows for the recovery of extraterritorial damages (in *Motorola*, they were calculated on the basis of the global revenue of the defendant). Second, the case illustrates the potential strategic implications of misappropriation remedies. Motorola and Hytera had been interacting in the same market for a decade, with Motorola hoping that litigation would bring back some of its lost business and Hytera knowing that a suit was imminent and that a potentially large share of its profits would be paid out in damages compensation.

This paper investigates the strategic implications of litigation over trade secrets. How does the prospect of recovering damages from an unfair competitor affect the market behavior of the victim of misappropriation? How aggressive will the competitor be in the face of liability that might end up forcing it to disgorge its entire profits?

While these questions have general bearing on litigation over intellectual property, our focus is on the misappropriation of trade secrets. Trade secrets are of special interest for two reasons. First, damages for their misappropriation can be calculated according to the lost-profits (LP) and the unjust-enrichment (UE) doctrines, which we compare below.[2] Second, trade secrets law leaves open the possibility for the rival to

1. Motorola started to suspect the leak in 2010. In 2017 Hytera was sued.

2. Since *Aro Manufacturing Co. v. Convertible Top Replacement Co.* (365 U.S. 336 [1961]), damages for utility-patent infringement are calculated uniquely on the basis of the lost-profits (LP) and the reasonable-royalty (RR) doctrines. The unjust-enrichment (UE) doctrine finds some application with respect to design patents. See Cotter (2013).

employ the technology of the original owner if he develops it by proper means. So one goal that damages awards can achieve is to deter the rival from employing unlawful means and instead pressure him to use lawful ones. This cannot occur under patent law, because patent infringement is, essentially, a strict-liability offense.[3]

To investigate the implications of damages awards on firms' conduct, we develop a simple model of Cournot competition between an incumbent (the original owner of the technology) and a rival. Depending on the cost of developing the technology independently, which is private information, the rival will acquire the technology by either proper or improper means. When competition takes place in the market, the incumbent does not know whether she is facing an honest or a dishonest rival. If the rival is dishonest, she will be able to recover damages at the litigation stage, and damages will be determined in accordance with either the LP or the UE doctrine (explained below). The model allows us to make predictions about the rival's conduct (to misappropriate or develop independently) and the firms' strategic behavior in the market. On the basis of these predictions, we can to draw conclusions about policy.

Before we discuss damages, it is useful to recapitulate the basic principles of trade secrets law. Most US states have adopted the Uniform Trade Secrets Act of 1985 (UTSA), which defines a trade secret as "information, including a formula, pattern, compilation, program, device, method, technique, or process, that: (i) derives independent economic value, actual or potential, from not being generally known . . . , and (ii) is the subject of efforts that are reasonable under the circumstances to maintain its secrecy" (UTSA, sec. 1.4).[4] In view of this definition, it is clear that the latitude of protection for trade secrets is extremely broad, extending far beyond the province of patentable inventions.

Proprietary information is misappropriated if it is obtained by "improper means," which include "theft, bribery, misrepresentation, breach or inducement of a breach of a duty to maintain secrecy, or espionage through electronic or other means" (UTSA, sec. 1.4). Proper means of acquisition include "1. Discovery by independent invention; 2. Discovery

3. Unlike trade secrets, patents provide an exclusive right: no third party can practice the patented technology without a license, regardless of how the third party obtains the technology. While trade secrets law encourages rivals to engage in fair competition, patent law encourages rivals to develop different (nonequivalent) products and processes.

4. A similar definition appears in the Agreement on Trade-Related Aspects of Intellectual Property Rights (art. 39) and in most legal systems throughout the world (see Lippoldt and Schultz 2014). In the United States, of special relevance is the *Restatement (Third) of Unfair Competition* (chap. 4).

by 'reverse engineering'. . . ; 3. Discovery under a license from the owner of the trade secret; 4. Observation of the item in public use or on public display; [and] 5. Obtaining the trade secret from published literature (UTSA, sec. 1, comment).[5]

Victims of misappropriation can seek damages and injunctive relief.[6] Injunctive relief, as in the case of patent infringement, can be obtained only under specific circumstances, bearing on the irreparability of the harm that continuing operations would entail (see *eBay Inc. v. MercExchange, L.L.C.* (547 U.S. 388 [2006]); for a broader picture, see Menell et al. 2020, chap. 2).

In turn, pecuniary damages for trade secrets misappropriation can be calculated using (at least) three different methods:[7]

The Lost-Profits Regime. Under this regime, damages are measured by the actual loss suffered by the victim. Typically, the victim claims the losses due to the reduction in sales and the price erosion caused by the unfair competitor. This remedy is in line with standard compensatory damages aimed at making the victim whole, that is, at restoring her to the position that she occupied before the tort.

The Unjust-Enrichment Regime. In this system, damages fully disgorge the unfair gain (an account of profits) made by the defendant. This remedy is in line with restitutory damages in tort and contract law, where the wrongdoer is compelled to give up the benefit obtained through the perpetration of the wrong, independent of any loss suffered by the victim.[8]

The Reasonable-Royalty Regime. In this regime, the plaintiff is awarded "the price that would be set by a willing buyer and a willing seller for the use of the trade secret made by the defendant" (*Restatement*

5. Note that the way in which the line between "proper" and "improper" is drawn is itself an important policy decision (see Friedman, Landes, and Posner 1991). In Franzoni and Kaushik (2016), we study the optimal scope of trade secrets protection in a game in which the probability of knowledge leakage depends on the efforts of both innovator and rival.

6. The statute of limitations for misappropriation claims ranges from 3 to 6 years, depending on the jurisdiction (with 3 years under the Defend Trade Secrets Act and 5 years in Illinois, which is relevant for the Hytera case; see Berkman Klein Center for Internet and Society 2014).

7. The same applies in Canada, China, Germany, Japan, and India. See Blair and Cotter (2005), Lippoldt and Schultz (2014), Këllezi, Kilpatrick, and Kobel (2017), and European Union Intellectual Property Office (2018).

8. In general, restitution follows a double rationale: deterrence, as it deprives wrongdoers of the gain from their illegal conduct, and autonomy, as it encourages parties to make contracts when they can instead of imposing costs and benefits on each other and calling for judicial valuation of them afterward. See Dari-Mattiacci (2009) and Farnsworth (2014) for a general perspective.

[Third] of Unfair Competition, sec. 45, comment g). In other words, courts try to calculate the royalty fee that the parties would have agreed to if they had entered into a negotiation before the misappropriation.

In most US states (but not in New York, and certainly not in Europe), the plaintiff can also recover exemplary damages if the defendant has engaged in "willful and malicious" misappropriation (USTA, sec. 3b). Exemplary damages cannot generally exceed two times the regular damages.

Finally, it should be noted that in most countries misappropriation of trade secrets gives rise to criminal liability. Under the US Economic Espionage Act of 1996 (Pub. L. No. 104-294, 110 Stat. 3488), amended by the DTSA, unauthorized appropriation of trade secrets is a federal crime.

From a review of a sample of federal and state civil court cases from 1950 to 2015 involving the misappropriation of trade secrets, Elmore (2016) finds that the LP regime represents the most common damages regime in both federal and state cases. For federal cases, the distribution was 53 percent LP, 13 percent UE, and 18 percent reasonable royalty (RR), with the rest (18 percent) undetermined. For state cases, the distribution was 68 percent LP, 28 percent UE, and 5 percent RR with the rest (18 percent) undetermined. The mean award (in 2015 dollars) was about $3 million for federal cases and $13 million for state cases. For both types of cases, there is a large variability in the figures. The UE regime yielded the largest average award. The LP regime's average award was about $4 million at the federal level and $467,000 at the state level. The UE regime's average award was $1.2 million at the federal level and $44 million at the state level. Finally, the average award for the RR regime was $2.6 million at the federal level and $100,000 at the state level. Exemplary damages were awarded in about a third of the cases.

In most jurisdictions, plaintiffs can chose the type of damages they intend to claim. Plaintiffs often rely on UE because, under that doctrine, damages flow directly from the violator's accounts. The victim of misappropriation can thus avoid disclosing information about her business. For the calculation of damages based on LP, plaintiffs normally employ the tools developed for patent infringement cases (lost market shares, price erosion, incremental income, convoyed sales, and so on). The quantification of the damages is more demanding (in terms of evidence), because it is based on the counterfactual reconstruction of what would have happened if the violator had not misappropriated the secret.[9] This is one

9. For the complexities of the quantifications, see, for instance, Almeling et al. (2018) and Seaman et al. (2019). Lost profits can be pursued only if the victim can produce a robust history of sales and profits for the technology subject to misappropriation.

reason plaintiffs often prefer to rely on UE. Clearly, another factor that can push plaintiffs toward one method or another has to do with the size of the resulting damages. If the misappropriator can rely on substantially better manufacturing and retailing facilities, UE is likely to provide greater damages.

In what follows, we analyze the competitive implications of the LP and UE regimes in isolation, assuming that only one of the two methods is available to the plaintiff. This allows us to compare the two doctrines from a policy perspective and to understand the welfare implications of policy moves that make one of the methods relatively more appealing at the litigation stage.

2. OVERVIEW OF THE RESULTS

2.1. Nonstrategic Analysis

In this basic setup, an incumbent firm is set to earn monopoly profits π_M thanks to her superior technology. A rival firm is interested in entering the same market. He can obtain the proprietary technology either through a licensing agreement or through misappropriation. If he enters the market, he will earn duopoly profit π_D^2, while the incumbent's profit becomes π_D^1. This situation gives rise to two basic scenarios.

In the first scenario, the rival does not bring superior manufacturing and retailing facilities. Essentially, the rival is just as efficient, or slightly more efficient, than the incumbent. The joint profits earned by the two firms do not exceed the monopoly profits previously earned by the incumbent: $\pi_D^1 + \pi_D^2 < \pi_M$. This is a situation in which the incumbent is not interested in licensing the technology to the rival. The rival, however, can misappropriate the technology and enter the market. Damages serve a deterrent function. Under LP, damages are equal to $D^{LP} = \pi_M - \pi_D^1$. If the rival misappropriates the technology and is found liable, the payoff to the incumbent is $\Pi_1^{LP} = \pi_D^1 + D^{LP} = \pi_M$. The incumbent obtains the same payoff that she would get by means of an injunction. The payoff to the rival, assuming that there is no solvency constraint, is $\Pi_2^{LP} = \pi_D^2 - \pi_M + \pi_D^1 < 0$: the rival suffers a loss. Under UE, damages are $D^{UE} = \pi_D^2$ with $D^{UE} < D^{LP}$. The payoff to the incumbent on misappropriation is now $\Pi_1^{UE} = \pi_D^1 + \pi_D^2 < \pi_M$. The payoff to the rival is $\Pi_2^{UE} = 0$. In this scenario, the incumbent is better off under LP, and the rival is better off under UE. Both damages regimes are able to deter misappropriation, and LP provides a higher sanction for the wrongdoer.

In the second scenario, the rival is substantially more efficient than the incumbent. The profits that he is able to make from the market plus the profits left to the incumbent exceed the monopoly profits previously earned by the incumbent: $\pi_D^1 + \pi_D^2 > \pi_M$. In this situation, it is in the interest of the incumbent to license the technology to the rival. Damages define here the outside options for the licensing agreement: if negotiations break down and the rival misappropriates the technology, damages will be paid. Under LP, the payoff to the incumbent is again $\Pi_1^{LP} = \pi_D^1 + D^{LP} = \pi_M$. The rival gets $\Pi_2^{LP} = \pi_D^2 - D^{LP} = \pi_D^1 + \pi_D^2 - \pi_M > 0$. The rival appropriates the full surplus from the (illegal) technology transfer. When negotiating the (legal) technology transfer, the rival can threaten the incumbent with misappropriation. The incumbent is in a weak bargaining position, and the licensing fee will be low.

Under UE, again $D^{UE} = \pi_D^2$ with $D^{UE} > D^{LP}$. The incumbent now appropriates the surplus from the illegal transfer: $\Pi_1^{UE} = \pi_D^1 + D^{UE} = \pi_D^1 + \pi_D^2 > \pi_M$; the rival gets nothing: $\Pi_2^{LP} = \pi_D^2 - D^{LP} = 0$. Under UE, misappropriation is not a credible threat. The licensing fee will be high.[10]

In this scenario, damages determine the bargaining power of the parties at the licensing stage. The function of the damages award is not to exert deterrence but rather to determine how the negotiation surplus is divided between the parties. Because we study the impact of damages on deterrence and market equilibrium, this is not the scenario on which we focus (but see Section 4).

The nonstrategic analysis takes π_D^1 and π_D^2 as given. In reality, parties have an incentive to alter their market behavior to either reduce or increase the damages award. The rival might also decide to develop the technology by legal means to avoid paying damages.

2.2. Strategic Analysis

In the model developed below, we assume that firms compete in quantities à la Cournot. The incumbent and rival are equally efficient in manufacturing (this rules out the second scenario above). The rival can decide whether to develop the relevant technology independently, develop it at a cost, or ferret it out of the incumbent for free. The cost of independent development can be observed only by the rival. When the incumbent observes the entry of a rival, she will formulate a belief that the rival is either an honest firm (that has developed the technology independently) or a dishonest firm (that has misappropriated). The truth can be known only

10. The RR calculated on the basis of the license fee that parties would have agreed on is also affected by the level of the damages (if damages are higher, the RR is also higher).

by means of a trial, at the end of which the dishonest rival will be held liable for damages. We assume that with a small probability the dishonest firm will escape liability. This small probability is necessary to provide the rival with incentives to pursue a rational strategy in the market game (if profits were disgorged with a 100 percent probability, any strategy would do).

Under LP, the dishonest firm knows that any loss inflicted on the incumbent will show up in the damages bill. He will therefore have an incentive to engage in a nonaggressive stance. The honest rival will be aggressive as usual (under Cournot competition). In the market equilibrium, the incumbent and the honest rival will produce the regular Cournot quantities, while the dishonest rival will produce a lower quantity. Thus, if the rival decides to be dishonest, total market quantity is smaller, and the market price is higher. Damages fully disgorge the rival's profits.

Under UE, the incumbent has a stake in the profits of the dishonest rival. Thus, she will be nonaggressive if she thinks that she is facing a misappropriator. Both the honest and the dishonest rivals will be aggressive as usual. In the market equilibrium, the incumbent will produce a small quantity, while the dishonest rival and the honest rival, in response, will produce relatively large quantities. The total market quantity will be smaller than under traditional Cournot competition but larger than under LP. Also in this case, damages will fully disgorge the dishonest rival's profits.

Under both LP and UE, misappropriation provides the rival with a payoff equal to (or close to) 0. The payoff to be netted from independent discovery differs across regimes and is higher under UE, where the honest firm obtains a larger market share. This implies that under UE the rival firm has greater incentives to duplicate the technology by legal means.

2.3. Policy Analysis

The model provides some guidance for the choice between damages regimes. Several factors come into play.

If the goal of the policy maker is to provide the owner of the secret knowledge with a large payoff as a reward for her innovative activity, the best damages regime is LP. Under that regime, the incumbent earns the largest market profits (since the dishonest rival is nonaggressive). Even if the damages are less than those under UE, the total payoff to the incumbent remains higher.

If the goal of the policy maker is to channel competition in the right direction by disincentivizing the use of improper means, then UE is the right regime. Under UE, the rival gets a higher reward from independent development and consequently misappropriates less.

If the goal of the policy maker is to balance the cost of restricted competition with the need to provide incentives to innovate, then the best regime is probably UE, since it yields the lowest deadweight loss per unit of (the innovator's) profit.[11] Under UE the prospect of a damages award has a limited distortionary effect on competition, since the rival produces a high quantity independently of whether he is honest or dishonest.

Finally, we note that if damages were not anchored to the incumbent's or the rivals' market sales, they would exert no distortionary effects on competition.[12] Damages that partially approximate this ideal regime are those based on "the value that a reasonably prudent investor would have paid for the trade secret" (investment value) or on "the development costs the defendant avoided incurring through misappropriation" (*Bohnsack v. Varco, L.P.,* 668 F.3d 262, 280 [5th Cir. 2012]).[13] The determination of damages in this way, however, is likely to be quite challenging, as development costs tend to be technology specific.

2.4. Literature

As far as we know, this paper represents the first attempt to analyze the impact of liability for misappropriation of trade secrets on firms' market behavior. A rich economic literature, starting with Schankerman and Scotchmer (2001), focuses on the impact of damages for patent infringement on competition and entry and assumes that the rival provides a product different from that of the original inventor, either because it represents an improvement (see, among others, Anton and Yao 2007; Hylton and Zhang 2017; Chen and Sappington 2018) or because if offers

11. The idea of using the ratio of deadweight loss to the innovator's profit for the evaluation of conduct that impinges on both innovation and competition is due to Kaplow (1984). It shares a rationale with the cost-effectiveness analysis employed for the evaluation of public projects.

12. Damages (for patent infringement) independent of firms' competitive choices have also been advocated by Friedman and Wickelgren (2019).

13. In *Ajaxo Inc. v. E*Trade Financial Corp.* (187 Cal. App. 4th 1295, 1305 [2010]), the court stated, "Where the plaintiff's loss does not correlate directly with the misappropriator's benefit . . . [a] defendant's unjust enrichment might be calculated based upon cost savings or increased productivity resulting from use of the secret." The court added, however, that "[t]here is no standard formula to measure it."

a different variety (Henry and Turner 2010).[14] In those cases, damages should strike a balance between the need to incentivize the original invention (without which the follow-on would not exist) and the need to provide consumers with a version of the product that better fits their wishes. Because of this, the choice of damages award is often intertwined with the optimal breadth of the patent, that is, how different the rival's innovation should be from the original in order not to infringe (Friedman and Wickelgren 2019). Though no clear-cut ranking of the two rules emerges, the arguments developed in Chen and Sappington (2018) suggest that LP best suits situations in which consumers attach a greater value to the original product, while UE best suits situations in which consumers attach a greater value to the follow-on product.

Of special interest for us is Choi (2009), in which the rival competes à la Cournot with an inventor who holds a probabilistic patent, that is, a patent that might turn out to be invalid.[15] Choi finds that if the patent holder and the infringer face the same marginal costs (as we assume), the patent holder obtains the largest payoff under LP, while the infringer obtains the largest payoff under UE. In terms of market outcomes, the two rules prove to be fully symmetric: under LP the infringer is nonaggressive, and under UE the patent holder is nonaggressive. The two rules therefore end up providing the same level of market welfare.

Our model retains the spirit of Choi (2009) with the important difference that we focus on the misappropriation of trade secrets. We study the choice of a rival who has the opportunity to compete either in a lawful or in an unlawful way (as explained above, this is not possible when the innovation is protected by a patent). The possibility that the rival develops the technology by proper means breaks the market symmetry between the regimes. Under LP, the dishonest rival is nonaggressive because he knows that he will be liable for damages. Under UE, the incumbent is somewhat nonaggressive because she believes that the rival might be dishonest and thus liable for damages. Because of this asymmetry, the UE regime provides higher market welfare and a greater reward for honesty.

14. Dey, Kaushik, and Pal (2020) study the impact of damages for patent infringement on optimal tariffs. They find that LP invites import tariffs, while UE invites import subsidies. Chopard, Cortade, and Langlais (2014) analyze the case in which the innovation allows the rival to reduce its production costs.

15. In practice, the prospect that the patent is declared invalid provides strong incentives to the parties to settle out of court. These incentives are missing in litigation over trade secrets.

3. THE MODEL

To enter a market occupied by an incumbent, a competitor has two options: he can either develop the technology independently or ferret it out illegally from the incumbent. Independent development entails a cost, while misappropriation entails the risk of litigation and payment of damages. The calculation of damages is based on either the LP or the UE doctrine.

The cost of independent development has cumulative probability distribution $G(c)$. The actual cost is known only to the rival. If the cost happens to be low, the rival will develop the technology independently; otherwise he will opt for cost-free misappropriation.

When the incumbent observes the entry of a new firm, she formulates a (consistent) belief about the nature of the rival: with a probability of θ the rival has misappropriated the technology (is dishonest), and with a probability of $1 - \theta$ the rival has developed it independently (is honest). The incumbent and the rival engage in competition over quantity (à la Cournot) in the market, knowing that if the technology has been misappropriated, the dishonest rival is liable for damages. To provide the rival with some incentives to engage in misappropriation, we assume that adjudication is imperfect: a dishonest rival will have to pay damages with a probability of $\alpha \leq 1$. Our focus is on the case in which α is close to 1.

The inverse demand in the market is assumed to be linear: $p = 1 - Q$, where Q is the quantity in the market.[16] The incumbent is firm 1, the dishonest rival is firm 2D, and the honest rival is firm 2H. So market quantity will be $q_1 + q_{2D}$ with a probability of θ and $q_1 + q_{2H}$ with a probability of $1 - \theta$. The marginal cost of production is assumed to be 0 for all firms.[17]

Firms decide their quantities simultaneously. Market profits of the incumbent are denoted $\pi_1(q_1, q_{2D})$ when it competes with the dishonest rival and $\pi_1(q_1, q_{2H})$ when it competes with the honest rival. Market profits of the dishonest rival are $\pi_{2D}(q_1, q_{2D})$, while those of the honest rival are $\pi_{2H}(q_1, q_{2H})$. Finally, monopoly profits, used in the calculation of LP dam-

16. Our results apply to generic linear demand functions with the shape $p = a - bQ$.

17. Since firms are equally efficient, under all circumstances joint duopoly profits cannot exceed monopoly profits. This implies that if the incumbent were free to choose the damages regime at the litigation stage, she would opt for LP. We assume that the damages regime is fixed in advance and cannot be changed.

ages, are equal to $\pi_M = (\frac{1}{2})^2$. As usual, we proceed by analyzing the last stages of the game first.

3.1. The Lost Profits Regime

Under the LP regime, damages are calculated on the basis of the actual loss for the incumbent:

$$D^{LP} = \pi_M - \pi_1(q_1, q_{2D}).$$

When the incumbent decides her market strategy, she does not know whether she is facing a dishonest rival, from which she will recover damages with a probability of α, or an honest rival, from which she cannot recover damages.

The expected payoff to the incumbent is

$$\begin{aligned}\Pi_1^{LP} &= \theta[\pi_1(q_1, q_{2D}) + \alpha D^{LP}] + (1-\theta)\pi_1(q_1, q_{2H}) \\ &= \theta q_1(1 - q_1 - q_{2D}) + (1-\theta)q_1(1 - q_1 - q_{2H}) + \theta\alpha[\tfrac{1}{4} - q_1(1 - q_1 - q_{2D})] \\ &= q_1[1 - q_1 - \theta q_{2D} - (1-\theta)q_{2H}] + \theta\alpha[\tfrac{1}{4} - q_1(1 - q_1 - q_{2D})].\end{aligned} \quad (1)$$

With a probability of θ the incumbent is facing a dishonest rival that will play q_{2D} and will be liable for damages with a probability of α.[18] With a probability of $1 - \theta$ she is facing an honest rival that will play q_{2H}. Clearly, damages increase if the incumbent makes a smaller profit.

The optimal quantity for the incumbent should meet

$$\frac{\partial \Pi_1^{LP}}{\partial q_1} = 1 - 2q_1 - \theta q_{2D} - (1-\theta)q_{2H} - \theta\alpha(1 - 2q_1 - q_{2D}) = 0,$$

and thus

$$q_1 = \frac{1 - \alpha\theta - q_{2D}(1-\alpha)\theta - (1-\theta)q_{2H}}{2(1-\theta\alpha)}.$$

Note how the prospect of compensatory damages affects the incumbent's behavior. Against a rival who is dishonest for sure ($\theta \to 1$) or honest for sure ($\theta \to 0$), the incumbent plays the Cournot best reply. When the rival can be either honest or dishonest, the incumbent focuses her reply mostly on the choice of the honest rival; a share of the profits she loses to the dishonest one she will recoup at the litigation stage.

18. If exemplary damages are considered, then damages might increase up to three times D^{LP}. So α would have to be multiplied by k, with $k \in [1, 3]$.

The optimal quantity for the dishonest rival should meet

$$\begin{aligned}\Pi_{2D} &= \pi_{2D}(q_1, q_{2D}) - \alpha[\pi_M - \pi_1(q_1, q_{2D})] \\ &= q_{2D}(1 - q_1 - q_{2D}) - \alpha[\tfrac{1}{4} - q_1(1 - q_1 - q_{2D})],\end{aligned} \tag{2}$$

and the optimal quantity is

$$(1 - q_1 - 2q_{2D}) - \alpha q_1 = 0$$

or

$$q_{2D} = \frac{1 - q_1(1 + \alpha)}{2}.$$

Note that the optimal quantity of the dishonest rival is reduced by the prospect of the damages award: if he produces a large quantity, the resulting reduction in price harms him twice: his products are sold with a lower margin and, because of price erosion, damages increase. For $\alpha \to 1$, the dishonest rival ends up maximizing joint profits: he sets $q_2 = \frac{1}{2} - q_1$, and the market price converges to the monopoly price.

For the honest rival,

$$\Pi_{2H} = q_{2H}(1 - q_1 - q_{2H}), \tag{3}$$

and thus

$$q_{2H} = \frac{1 - q_1}{2}$$

as in a standard Cournot game.

Combining the three best reply functions yields

$$q_1^{LP} = \frac{1 - \theta\alpha}{3 - \alpha\theta(4 - \alpha)}, \qquad q_{2D}^{LP} = \frac{2 - \alpha - \theta\alpha(3 - 2\alpha)}{6 - 2\theta\alpha(4 - \alpha)},$$
$$\text{and} \qquad q_{2H}^{LP} = \frac{2 - \theta\alpha(3 - \alpha)}{6 - 2\theta\alpha(4 - \alpha)} \tag{4}$$

with

$$q_1^{LP} \geq q_{2H}^{LP} \geq q_{2D}^{LP}$$

and

$$\pi_1^{LP} \geq \pi_{2H}^{LP} \geq \pi_{2D}^{LP} \geq 0.$$

As θ increases, the probability that the incumbent is facing a nonaggressive dishonest rival increases, and q_1^{LP} increases. As a consequence, both q_{2D}^{LP} and q_{2H}^{LP} decrease.

The payoffs to the parties are

$$\Pi_1^{LP} = \frac{4 - 3\theta\alpha - 6\theta^2\alpha^2(2 - \alpha) + \theta^3\alpha^3(12 - 8\alpha + \alpha^2)}{4[3 - \theta\alpha(4 - \alpha)]^2},$$

$$\Pi_{2D}^{LP} = \frac{(1 - \alpha)[4 - (1 + 12\theta)\alpha + 3\theta(2 + 3\theta)\alpha^2 - 7\theta^2\alpha^3 + \alpha^2\theta^2]}{4[3 - \theta\alpha(4 - \alpha)]^2},$$

and

$$\Pi_{2H}^{LP} = \frac{[2 - \theta\alpha(3 - \alpha)]^2}{4[3 - \theta\alpha(4 - \alpha)]^2},$$

with

$$\Pi_1^{LP} \geq \Pi_{2H}^{LP} \geq \Pi_{2D}^{LP} \geq 0. \tag{5}$$

With perfect adjudication ($\alpha \to 1$),

$$q_1^{LP} = q_{2H}^{LP} = \frac{1}{3} \quad \text{and} \quad q_{2D}^{LP} = \frac{1}{6}.$$

The incumbent and the honest rival produce standard Cournot quantities, while the dishonest rival produces a quantity small enough to yield a monopolistic market price. The market price will thus be equal to $\frac{1}{2}$ with a probability of θ and $\frac{1}{3}$ with a probability of $(1 - \theta)$. Figure 1 shows the game.

The damages awarded are

$$D_{\alpha=1}^{LP} = (q_M - q_1)p_M = \left(\frac{1}{2} - \frac{1}{3}\right)\frac{1}{2} = \frac{1}{12}. \tag{6}$$

The rival is liable for the diverted sales but not for price erosion.

The payoffs to the players are

$$\Pi_1^{LP} = \frac{1}{9} + \frac{5}{36}\theta, \qquad \Pi_{2D}^{LP} = 0, \qquad \text{and} \qquad \Pi_{2H}^{LP} = \frac{1}{9}.$$

Under perfect adjudication, the profits of the incumbent increase with the probability of misappropriation θ. The incumbent is better off without rivals. But if she has to have a rival, it is better to have a nonaggressive one who is liable for damages.

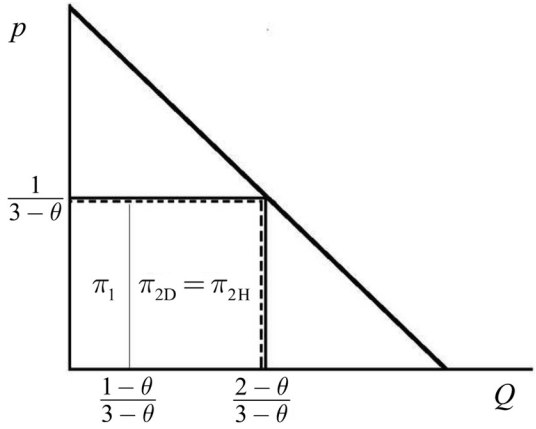

Figure 1. Market outcomes under a lost-profits regime

3.2. The Unjust-Enrichment Regime

Under the UE regime, the incumbent can recover the profits made by the dishonest rival.[19] Thus,

$$D^{UE} = \pi_{2D}(q_1, q_{2D}).$$

The expected payoff to the incumbent is

$$\begin{aligned}\Pi_1^{UE} &= \theta[\pi_1(q_1, q_{2D}) + \alpha D^{UE}] + (1-\theta)\pi_1(q_1, q_{2H}) \\ &= \theta\pi_1(q_1, q_{2D}) + (1-\theta)\pi_1(q_1, q_{2H}) + \theta\alpha\pi_{2D}(q_1, q_{2D}) \\ &= q_1[1 - q_1 - \theta q_{2D} - (1-\theta)q_{2H}] + \theta\alpha q_{2D}(1 - q_1 - q_{2D}).\end{aligned} \tag{7}$$

The optimal quantity of the incumbent should satisfy

$$\frac{\partial \Pi_1^{UE}}{\partial q_1} = 1 - 2q_1 - \theta q_{2D} - (1-\theta)q_{2H} - \theta\alpha q_{2D} = 0,$$

and thus

$$q_1 = \frac{1 - q_{2D}\theta(1+\alpha) - (1-\theta)q_{2H}}{2}.$$

The incumbent is highly concerned about a reduction in the market price because this affects both her revenue and the revenue of her rival,

19. In an alternative interpretation of the model, UE represents the case in which recoverable damages are constrained by the level of the rival's profits.

which she can appropriate through the damages award. So it is the incumbent now who pursues a nonaggressive strategy.

The expected payoff to the dishonest firm is

$$\Pi_{2D}^{UE} = (1-\alpha)\pi_2(q_1, q_{2D}) = (1-\alpha)q_2(1-q_1-q_{2D}). \tag{8}$$

The dishonest rival can only hope to escape judgment. His payoff is just $(1-\alpha)$ of standard duopoly profits. The optimal quantity is therefore

$$q_{2D} = \frac{1-q_1}{2},$$

as in a standard Cournot game.

The payoff to the honest rival is

$$\Pi_{2H}^{UE} = \pi_2(q_1, q_{2H}) = q_{2H}(1-q_1-q_{2H}), \tag{9}$$

which yields again the standard Cournot best reply:

$$q_{2H} = \frac{1-q_1}{2}.$$

Combining the best replies yields

$$q_1^{UE} = \frac{1-\theta\alpha}{3-\theta\alpha}, \qquad q_{2D}^{UE} = \frac{1}{3-\theta\alpha}, \qquad \text{and} \qquad q_{2H}^{UE} = \frac{1}{3-\theta\alpha} \tag{10}$$

with

$$q_{2D}^{UE} = q_{2H}^{UE} \geq q_1^{UE}$$

and

$$\pi_{2D}^{UE} = \pi_{2H}^{UE} \geq \pi_1^{UE}.$$

Under UE, the incumbent plays a nonaggressive market strategy against a dishonest rival. As the probability of misappropriation increases, the optimal quantity of the incumbent decreases. In turn, the quantity produced by the rival, honest or dishonest, increases.

Because of her reliance on damages, the incumbent earns the lowest market profits among the three firms. This outcome is in sharp contrast to the LP regime, in which the incumbent earns the largest market profits.

The firms' payoffs are

$$\Pi_1^{UE} = \frac{1}{(3-\theta\alpha)^2}, \qquad \Pi_{2D} = \frac{1-\alpha}{(3-\theta\alpha)^2}, \qquad \text{and} \qquad \Pi_{2H} = \frac{1}{(3-\theta\alpha)^2},$$

with

$$\Pi_1^{UE} = \Pi_{2H}^{UE} \geq \Pi_{2D}^{UE}.$$

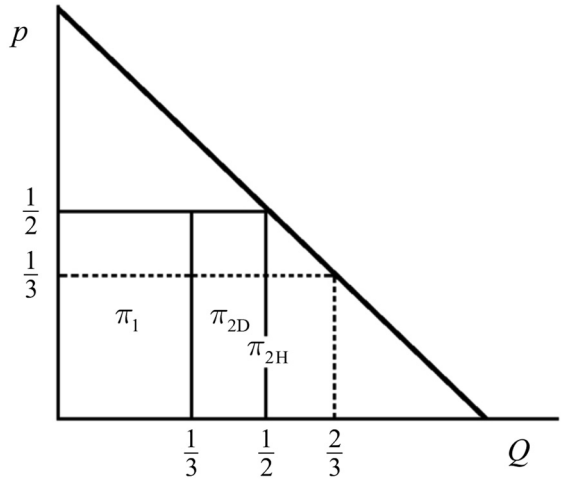

Figure 2. Market outcomes under an unjust-enrichment regime

Again, the dishonest rival obtains the lowest payoff, since he has to disgorge his profits. Note that the payoffs to the dishonest and the honest rivals both increase with θ: as the incumbent takes a less aggressive stance, both rivals earn larger profits.

With perfect adjudication ($\alpha \to 1$),

$$q_1^{\mathrm{UE}} = \frac{1-\theta}{3-\theta} \qquad \text{and} \qquad q_{2\mathrm{D}}^{\mathrm{UE}} = q_{2\mathrm{H}}^{\mathrm{UE}} = \frac{1}{3-\theta}.$$

The dishonest and the honest rival produce quantities larger than the Cournot quantity, while the incumbent produces a quantity lower than the Cournot quantity. If the incumbent were sure to face a dishonest rival, she would produce nothing, and she would extract the rival's monopolistic profits in the form of damages. Figure 2 shows the game.

Damages are now

$$D_{\alpha=1}^{\mathrm{UE}} = q_{2\mathrm{H}}^{\mathrm{UE}}(1 - q_1^{\mathrm{UE}} - q_{2\mathrm{H}}^{\mathrm{UE}}) = \frac{1}{3-\theta}\left(1 - \frac{1-\theta}{3-\theta} - \frac{1}{3-\theta}\right) = \frac{1}{(3-\theta)^2}. \quad (11)$$

Under UE, the profit of the dishonest rival—and thus damages—is higher if the probability of misappropriation is higher and the incumbent plays a less aggressive strategy.

The parties' payoffs are now

$$\Pi_1^{\mathrm{UE}} = \frac{1}{(3-\theta)^2}, \qquad \Pi_{2\mathrm{D}} = 0, \qquad \text{and} \qquad \Pi_{2\mathrm{H}} = \frac{1}{(3-\theta)^2}.$$

The honest rival gains if θ increases, and the incumbent becomes less aggressive.

3.3. Lost Profits versus Unjust Enrichment

Independent discovery of the technology used by the incumbent requires an investment equal to c. This cost is distributed on [0, 1] with cumulative distribution function $G(c)$. From now on, we focus on the case in which $\alpha \to 1$.

Under LP, the ex ante payoff to the rival is

$$\widehat{\Pi}_{2D}^{LP} = 0 \quad \text{if he misappropriates}$$

and

$$\widehat{\Pi}_{2H}^{LP} = \frac{1}{9} - c \quad \text{if he develops independently.}$$

The rival will misappropriate only if $c > \overline{c}^{LP} = \frac{1}{9}$.[20] The probability of misappropriation is $\theta^{LP} = 1 - G(\frac{1}{9})$. The duplication expenditure is $C^{LP} = \int_0^{\overline{c}^{LP}} cdG'(c)$.

Under UE, the ex ante payoff to the rival is

$$\widehat{\Pi}_{2D}^{UE} = 0 \quad \text{if he misappropriates}$$

and

$$\widehat{\Pi}_{2H}^{UE} = \frac{1}{(3-\theta)^2} - c \quad \text{if he develops independently.}$$

If a larger fraction of rivals misappropriate, Π_{2H}^{UE} increases, and the incentive to misappropriate decreases. The cost threshold $\overline{c}^{UE}$ should meet

$$\frac{1}{\{3 - [1 - G(\overline{c}^{UE})]\}^2} - \overline{c}^{UE} = 0$$

with $\overline{c}^{UE} > \frac{1}{9}$. The probability of misappropriation is $\theta^{UE} = 1 - G(\overline{c}^{UE}) < \theta^{LP}$, and duplication expenditure is $C^{UE} = \int_0^{\overline{c}^{UE}} cdG'(c) > C^{LP}$.

In sharp contrast to the nonstrategic setting, UE exerts more deterrence than LP. In a strategic setting, the payoff to the dishonest rival cannot go below 0—otherwise the rival would quit the market. So the incentives to misappropriate are driven uniquely by the profits that the rival

20. The fact that α is close but not equal to 1 guarantees that misappropriators do not leave the market. In a similar vein, Choi (2009) uses $\alpha \to 1$ to select among multiple equilibria in the patent infringement game.

can make by developing the technology by legal means. These profits are higher under UE, where the incumbent takes a nonaggressive stance.

The incumbent's market profits under the two regimes are

$$\pi_1^{\mathrm{LP}} = \frac{1}{3}\left[1 - \frac{1}{3} - \theta^{\mathrm{LP}}\frac{1}{6} - (1 - \theta^{\mathrm{LP}})\frac{1}{3}\right] = \frac{1 + (\theta^{\mathrm{LP}}/2)}{9} > \frac{1}{9}$$

and

$$\pi_1^{\mathrm{UE}} = \frac{1-\theta}{3-\theta}\left(1 - \frac{1-\theta^{\mathrm{UE}}}{3-\theta^{\mathrm{UE}}} - \frac{1}{3-\theta^{\mathrm{UE}}}\right) = \frac{1-\theta^{\mathrm{UE}}}{(3-\theta^{\mathrm{UE}})^2} < \frac{1}{9}.$$

Thus,

$$\pi_1^{\mathrm{LP}} > \pi_1^{\mathrm{UE}}.$$

The incumbent earns greater market profits in the LP regime. In the UE regime, the incumbent sacrifices her profits to increase the damages award.

By comparing equations (6) and (11), we can easily see that

$$D^{\mathrm{UE}} > D^{\mathrm{LP}}.$$

Under UE, the incumbent gives room to the rival so as to increase damages. Under LP, the dishonest rival reduces his production to reduce damages.

Taking profits and damages into account yields

$$\Pi_1^{\mathrm{LP}}(\theta^{\mathrm{LP}}) = \frac{1}{9} + \frac{5}{36}\theta^{\mathrm{LP}}$$

and

$$\Pi_1^{\mathrm{UE}}(\theta^{\mathrm{UE}}) = \frac{1}{(3-\theta^{\mathrm{UE}})^2},$$

with

$$\Pi_1^{\mathrm{LP}}(\theta^{\mathrm{LP}}) > \Pi_1^{\mathrm{LP}}(\theta^{\mathrm{UE}}) > \Pi_1^{\mathrm{UE}}(\theta^{\mathrm{UE}})$$

since $\theta^{\mathrm{LP}} > \theta^{\mathrm{UE}}$.

The net payoff to the incumbent is larger under LP. The higher damages that the incumbent receives under UE are not sufficient to compensate for the lower market profits.

The market profits of the dishonest rival are

$$\pi_{2\mathrm{D}}^{\mathrm{LP}} = \frac{1}{6}\left(1 - \frac{1}{3} - \frac{1}{6}\right) = \frac{1}{12}$$

and

$$\pi_{2D}^{UE} = \frac{1}{3-\theta^{UE}}\left(1 - \frac{1-\theta^{UE}}{3-\theta^{UE}} - \frac{1}{3-\theta^{UE}}\right) = \frac{1}{(3-\theta^{UE})^2} > \frac{1}{9}.$$

Thus,

$$\pi_{2D}^{UE} > \pi_{2D}^{LP}.$$

Under UE the dishonest rival earns higher market profits and pays higher damages.

The market profits of the honest rival are

$$\pi_{2H}^{LP} = \frac{1}{9}$$

and

$$\pi_{2H}^{UE} = \frac{1}{(3-\theta^{UE})^2} > \frac{1}{9}.$$

Thus,

$$\pi_{2H}^{UE} > \pi_{2H}^{LP}.$$

Since the payoff to the honest rival is higher under UE, while the payoff to the dishonest rival and the opportunities to duplicate are the same under both regimes, in expected terms the rival's payoff is higher under UE.

Market quantities are

$$Q^{LP}(\theta^{LP}) = \frac{1}{3} + \theta^{LP}\frac{1}{6} + (1-\theta^{LP})\frac{1}{3} = \frac{2}{3} - \frac{1}{6}\theta^{LP}$$

and

$$Q^{UE}(\theta^{UE}) = \frac{1-\theta^{UE}}{3-\theta^{UE}} + \frac{1}{3-\theta^{UE}} = \frac{2-\theta^{UE}}{3-\theta^{UE}}.$$

Since the quantities decrease with θ and $\theta^{LP} > \theta^{UE}$,

$$Q^{UE}(\theta^{UE}) > Q^{UE}(\theta^{LP}) > Q^{LP}(\theta^{LP}).$$

The latter result is particularly important, since market welfare (consumer surplus plus producers' surplus) is proportional to Q.

If Δ denotes the standard market deadweight loss (maximum feasible welfare minus actual welfare),

$$\Delta^{UE} = \frac{1}{2}[1 - Q^{UE}(\theta^{UE})]^2 < \frac{1}{2}[1 - Q^{LP}(\theta^{LP})]^2 = \Delta^{LP}.$$

Under UE, damages have a less distortionary impact on competition. Proposition 1 is based on the assumption of (nearly) perfect adjudication ($\alpha \to 1$).

Proposition 1. The LP and UE doctrines affect competition and misappropriation decisions in different ways. In equilibrium, under LP there are larger market profits for the incumbent, $\pi_1^{LP} > \pi_1^{UE}$; lower damages awards, $D^{LP} < D^{UE}$; a larger payoff for the incumbent (including market profits and damages), $\Pi_1^{LP} > \Pi_1^{UE}$; lower market profits for the dishonest rival, $\pi_{2D}^{LP} < \pi_{2D}^{UE}$; an invariant payoff for the dishonest rival (including market profits and damages), $\widehat{\Pi}_{2D}^{LP} = \widehat{\Pi}_{2D}^{UE} = 0$; lower market profits for the honest rival, $\pi_{2H}^{LP} < \pi_{2H}^{UE}$; a greater probability of misappropriation, $\theta^{LP} > \theta^{UE}$; a lower duplication expenditure, $C^{LP} < C^{UE}$; and a greater market deadweight loss, $\Delta^{LP} > \Delta^{UE}$.

Proposition 1 shows that the two damages regimes provide sharply different strategic incentives. In the LP regime, in which damages depend on the incumbent's actual loss, the dishonest rival gives up some of his profits to increase the incumbent's market share and thus reduce his prospective liability. The incumbent earns a larger payoff (profits plus damages), even if damages are lower. When the honest rival comes up against the incumbent, competition is relatively intense, and the rival's profits are low.

In the UE regime, in which damages disgorge the dishonest rival's profits, the incumbent will not be aggressive against the rival. Damages are high, but the incumbent's total payoff is low. The honest rival, facing a relatively soft incumbent, makes high profits.

While the dishonest rival obtains no payoff under both regimes, the honest rival earns a higher profit under UE, where he faces a soft incumbent. So the UE regime provides the rival with greater incentives to develop the technology independently and avoid liability.

3.4. Policy Considerations

The previous observations leave us with the hard task of comparing the two damages regimes from a policy perspective. A variety of factors come into play.

3.4.1. Incentives to Innovate. If the main purpose of trade secrets law is to promote the creation of innovative knowledge, then we should focus on the reward for the innovator. Here LP performs better, as it provides a

greater payoff to the incumbent: $\Pi_1^{LP} > \Pi_1^{UE}$. Note that, in contrast to the nonstrategic case, now the reward to the innovator does not derive from higher damages awards but from higher market profits. The LP regime softens the competition from dishonest rivals concerned about the loss they cause to the plaintiffs.

3.4.2. Deterrence. Trade secrets law offers a very special type of protection to innovators. It does not provide them with an exclusive right to use an invention (as a patent would). It protects them only from the competition of rivals who have obtained the technology by improper means. In fact, trade secrets law provides ample leeway to competition by proper means, for example, by allowing reverse engineering. If the goal of trade secrets law is to channel competition into the proper means, then UE is the preferred regime. It provides the rival with the strongest incentives not to engage in misappropriation.

3.4.3. Market Deadweight Loss. In deciding the scope of the protection that the law grants to holders of secret knowledge, the lawmaker cannot ignore the costs that such protection is likely to inflict on consumers. As we have shown, the different damages regimes tend to distort firms' market behavior, effectively curbing competition. The regime that provides the greatest benefits to consumers is UE. Under that regime, the incumbent reduces to some extent her production, while both the honest rival and the dishonest rival produce larger quantities. Competition remains healthy, although not as healthy as under Cournot competition.

3.4.4. Deadweight-to-Profit Ratio. Trade secrets law is not the only tool available to firms to protect their innovative knowledge. If the innovation meets the requirements of novelty and nonobviousness, it can be protected by a patent. In the comparison of protection tools and of conduct that impinges on competition and innovation, a rough index of the overall desirability of a tool is the ratio of deadweight loss to profit: it measures the social cost associated with each unit of profit netted by the innovator. Given that a reward has to be provided to the innovator for the innovation to occur, the ideal intellectual property right should entail the least cost for each dollar of reward.[21]

21. This methodology, first developed in Kaplow (1984), has been successfully applied to intellectual property rights by several authors. See Scotchmer (2004), Denicolò and Franzoni (2010, 2012), Friedman and Wickelgren (2019), and references therein.

In our case,

$$\frac{\Delta^{\mathrm{LP}}}{\Pi_1^{\mathrm{LP}}} = \frac{(1/2)\{1-[(2/3)-(1/6)\theta^{LP}]\}^2}{(1/9)+(5/36)\theta^{\mathrm{LP}}} < \frac{(1/2)\{1-[(2-\theta^{\mathrm{UE}})/(3-\theta^{\mathrm{UE}})]\}^2}{1/(3-\theta^{\mathrm{UE}})^2} = \frac{\Delta^{\mathrm{UE}}}{\Pi_1^{\mathrm{UE}}} = \frac{1}{2}. \tag{12}$$

Note that the ratio of deadweight loss to profit under UE is equal to that under standard Cournot competition.[22]

Inequality (12) is strengthened by the fact that, under LP, the expected duplication costs (which add to the deadweight loss) are smaller. This confirms that the social cost of each dollar of profit earned by the innovator-incumbent is smaller under LP.

Finally, it is worth noting that the market deadweight loss would be even smaller if the prospect of damages awards did not interfere with the firms' market choices. If damages were independent of the profits that firms make in market competition, firms would compete à la Cournot. Market profits would be equal to $\frac{1}{9}$ for all firms.

For $D \leq \frac{1}{9}$, the payoff of the rival would be

$$\widehat{\Pi}_{2\mathrm{D}}^{\mathrm{LP}} = \frac{1}{9} - D \quad \text{if he misappropriates}$$

and

$$\widehat{\Pi}_{2\mathrm{H}}^{\mathrm{LP}} = \frac{1}{9} - c \quad \text{if he develops independently.}$$

The rival misappropriates if $D \geq c$, and the share of misappropriators is $\theta^C = 1 - G(D)$. For $D > \frac{1}{9}$, the rival either develops the technology independently (for costs $c \in [0, \frac{1}{9}]$) or leaves the market.

The payoff to the incumbent is (for $D \leq \frac{1}{9}$)

$$\Pi_1^{\mathrm{C}} = \frac{1}{9} + \theta^{\mathrm{C}} D.$$

Market quantities are $q_1^{\mathrm{C}} = q_{2\mathrm{D}}^{\mathrm{C}} = q_{2\mathrm{H}}^{\mathrm{C}} = \frac{1}{3}$, and the deadweight loss is

$$\Delta^{\mathrm{C}} = \frac{1}{2}\left(\frac{1}{3}\right)^2 < \Delta^{\mathrm{UE}} < \Delta^{\mathrm{LP}}.$$

22. We have $q_1^{\mathrm{UE}} = (1-\theta)q_{2\mathrm{D}}^{\mathrm{UE}}$. Thus, $\Pi_1^{\mathrm{UE}} = q_1^{\mathrm{UE}} p^{\mathrm{UE}} + \theta q_{2\mathrm{D}}^{\mathrm{UE}} p^{\mathrm{UE}} = q_2^{\mathrm{UE}} p^{\mathrm{UE}} = \pi_{2\mathrm{D}}^{\mathrm{UE}}$. Since the dishonest rival plays a Cournot best reply, he acts like a monopolist on the residual demand curve. The ratio between the deadweight loss and $\pi_{2\mathrm{D}}^{\mathrm{UE}}$ is thus the same as under monopoly (and under Cournot competition).

A suitable choice of D can provide the incumbent with the same payoff that she would get under either LP or UE but with a lower market deadweight loss.

The difficulty with such a damages regime is that it offers little guidance to the courts. For instance, if courts intend to set damages at the level that completely discourages misappropriation, $D = \frac{1}{9}$, they would need to speculate about the level of profits that firms would make if they did not act strategically (in general, this depends on the shape of the demand curve and the level of the production costs). Still, there are methods of calculating damages that do not depend on market outcomes. Damages calculated on the basis of the technology development costs, for instance, share this feature (see Section 1).

4. EXTENSIONS

4.1. Imperfect Enforcement

Our analysis considers the ideal case in which a dishonest rival is always liable for misappropriation. The strategic incentives apply with full vengeance. Do the results hold when misappropriation does not carry liability? Simulations performed on the general formulas of our model show that the analysis carries through if α is not too small (with a uniform distribution of the costs, this means $\alpha \geq .18$).[23] When α is very small, the prospect of liability appears very remote: the dishonest firm behaves very much like the honest one, and the incumbent is not concerned about the type she is facing. All firms produce quantities close to Cournot quantities ($\frac{1}{3}$ each). Damages, when they happen to be awarded, are higher under LP (they are close to $\frac{1}{4} - \frac{1}{9}$) than under UE (they are close to $\frac{1}{9}$). If solvency is not an issue, the incentive not to misappropriate is larger under LP. The deadweight loss is the same under both damages regimes. Essentially, the nonstrategic analysis applies.

4.2. More Efficient Rival

When the rival's manufacturing and retailing facilities are better than the incumbent's,[24] the rival faces a marginal cost that is lower than that of

23. For some values of α, $\widehat{\Pi}_{2H}^{LP} - \widehat{\Pi}_{2D}^{LP}$ is nonmonotonic in θ, and multiple Nash equilibria arise. From the set of the equilibria, we focus on the stable one.

24. The case in which the rival is less efficient than the incumbent cannot be analyzed under the hypothesis that α is close to 1. The rival is not able to pay LP damages to the incumbent without incurring a loss. The payoff from dishonesty is thus negative, and this implies that competition can occur only when there is honest duplication.

the incumbent (see the Appendix for a formal analysis). Under LP, the dishonest rival nets a positive payoff. Under EU, all profits of the dishonest rival are extracted. The incumbent plays a very soft market strategy to enhance the profits of the dishonest rival. If the rival is dishonest with a sufficiently large probability, the incumbent produces nothing. Under UE, damages are higher, and so is the difference in payoff between honesty and dishonesty. While the strategic analysis retains the same features as before (the inequalities of proposition 1 apply), a further effect should be noted. Recall that under LP the dishonest rival plays a nonaggressive strategy. Under UE, the incumbent plays a nonaggressive strategy. For this reason, under UE the rival takes a larger share of the market, and this reduces the production inefficiency (that is, the additional production costs due to the fact that the inefficient plant is used). This effect should be accounted for in the calculation of the deadweight loss associated with the two damages rules.

Finally, let us consider the case in which the efficiency advantage of the rival is so large that licensing becomes profitable ($\pi_D^1 + \pi_D^2 > \pi_M$, where π_D^1 and π_D^2 are the profits under licensing). In line with the nonstrategic analysis, misappropriation and duplication are used as bargaining threats: they define the payoff levels that parties would obtain if the negotiation broke down. In this counterfactual situation, firms would still act strategically, and the results of the previous paragraph would apply. What matters now are the payoffs to the parties: $\Pi_1^{LP} > \Pi_1^{UE}$, $\widehat{\Pi}_{2D}^{LP} > \widehat{\Pi}_{2D}^{UE} = 0$, $\widehat{\Pi}_{2H}^{UE} > \widehat{\Pi}_{2H}^{LP}$. The incumbent nets a higher payoff under LP. Under UE, the incumbent plays a soft market strategy and obtains very small market profits. That damages are higher does not make up for the missing market profits. The payoff to the dishonest rival is higher under LP, while the payoff to the honest rival is higher under UE (thanks to the soft stance of the incumbent).

The preferences of the rival with respect to the damages regime depend on his development cost. If the development cost is high, so he is bound to be dishonest, then he prefers LP. If the development cost is low, so he can afford to be honest, then he prefers UE. For intermediate values, the rival is honest under UE and dishonest under LP. The comparison of the two regimes is ambiguous because the payoff under UE depends on the probability of dishonesty (and this, in turn, depends on the distribution of the duplication costs).

These hypothetical (and rather speculative) payoffs define the outside options in the licensing negotiation. The outside options affect only the allocation of the negotiation surplus; they have no impact on market

quantities, deadweight loss, probability of misappropriation, and so on because, in equilibrium, the technology will be licensed. Damages serve a distributive purpose, as they affect the rewards for incumbent and rival. A policy choice based on efficiency considerations should then look at additional factors, like whether the reward for the incumbent is large enough to incentivize the development of the original technology and the reward for the rival is large enough to incentivize the investment in (superior) manufacturing and retailing facilities.

5. FINAL REMARKS

Trade secrets litigation has recently attracted sustained attention. The establishment of a federal cause of action for misappropriation under the DTSA and the remarkable magnitude of recent damages awards invite scholarly reflection on the implications of liability for misappropriation on firms' strategic incentives.

Our model offers insights that should allow courts and policy makers to better understand the subtle market effects of the various damages doctrines. We considered LP and UE in isolation. They offer diverging incentives to develop original knowledge, to carry out unlawful practices, and to compete in the market. Either doctrine could be preferred depending on the desiderata of the policy maker. If the focus is on rewarding the production of innovative knowledge, then LP is likely to perform better, as it provides the greatest payoff to the trade secret's original owner. Perhaps surprisingly, if the focus is on deterring unlawful practices, then UE seems to perform better, as it provides a greater reward to honest competitors. Finally, if the goal is to contain the deadweight loss associated with the incentive to innovate, then LP seems to perform better, because it yields a lower ratio of deadweight loss to profit.

Our analysis assumes away some important factors. In particular, we do not consider the possibility that the rival develops a product to which consumers attach a greater value, and we do not account for litigation costs. Furthermore, we posit errorless adjudication. With these caveats in mind, we are confident that our contribution provides a good starting point to understand the complex strategic implications of remedies for misappropriation.

APPENDIX: EFFICIENT RIVAL

Let us consider the case in which the rival is more efficient than the incumbent. To be specific, the marginal production cost of the rival is 0, while the marginal production cost of the incumbent is $c \leq \frac{1}{2}$. Monopoly profits are $\pi_M = [(1 - c)/2]^2$. Going through the same steps as in Section 3, we obtain the following results.

Under LP, the market quantities are

$$q_1^{LP} = \frac{1 - 2c}{3}, \qquad q_{2D}^{LP} = \frac{1 + 4c}{6}, \qquad \text{and} \qquad q_{2H}^{LP} = \frac{1 + c}{3}.$$

With a probability of θ, the market price is $p = \frac{1}{2}$, damages are $D^{LP} = (1 + 2c - 5c^2)/12$, and the payoff to the incumbent is $\Pi_1 = \pi_M = [(1 - c)/2]^2$, while the payoff to the dishonest rival is $\Pi_{2D}^{LP} = \pi_{2D}^{LP} - D^{LP} = c(2 + 5c)/12$. With a probability of $1 - \theta$, the market price is $p = (1 + c)/3$ and the payoff to the incumbent is $\Pi_1 = [(1 - 2c)/3]^2$, while the payoff to the honest rival is $\Pi_{2H}^{LP} = [(1 + c)/3]^2$. The production inefficiency is $q_1^{LP} \times c = (1 - 2c)c/3$.

Under UE,

$$q_1^{UE} = \frac{1 - \theta - 2c}{3 - \theta} \qquad \text{and} \qquad q_{2D}^{UE} = q_{2H}^{UE} = \frac{1 + c}{3 - \theta} \quad \text{for } \theta < 1 - 2c.$$

For $\theta \geq 1 - 2c$, the incumbent produces $q_1^{UE} = 0$ and hopes to recover damages from the dishonest rival. The rivals, in turn, behave like monopolists and set $q_{2D}^{UE} = q_{2H}^{UE} = \frac{1}{2}$.

For $\theta < 1 - 2c$, the market price is $p^{UE} = (1 + c)/(3 - \theta)$. The market profits of the incumbent are $\pi_1^{UE} = [1 - c^2(2 - \theta)](1 - \theta - 2c)/(3 - \theta)^2$. Damages are equal to the market profits of the dishonest rival: $D^{UE} = \pi_{2D}^{UE} = [(1 + c)/(3 - \theta)]^2$. The total payoff to the incumbent is $\Pi_1^{UE} = [1 + (4 - \theta)c^2 - c(4 - 5\theta + \theta^2)]/(3 - \theta)^2$. Given θ, the payoff to the incumbent is nonmonotonic in c (first it is decreasing, and then it is increasing). The production inefficiency amounts to $q_1^{UE} \times c = (1 - \theta - 2c)c/(3 - \theta)$.

For $\theta \geq 1 - 2c$, the rival takes the whole market. There is no production inefficiency.

Even if damages are higher under UE, the payoff to the incumbent is higher under LP (thanks to the higher market profits). The incentives to be honest are higher under UE. The payoff to the honest rival is higher under UE, thanks to the nonaggressive stance of the incumbent. The payoff to the dishonest rival is higher under LP, since in this regime he retains part of his profits.

From an ex ante perspective, a rival with a low duplication cost, and hence one who is honest, is better off under UE. A rival with a high duplication cost, and hence one who is dishonest, is better off under LP. A rival with an intermediate duplication cost will be honest under UE and dishonest under LP. The two payoffs cannot unambiguously be compared because the payoff under UE depends on the share of dishonest rivals in equilibrium, which in turn depends on the distribution of the duplication costs.

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