Secrecy and Safety

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ABSTRACT

We provide a model showing that the use of confidential settlement as a strategy for a firm facing tort litigation leads to lower average safety of products sold than would occur if the firm were committed to openness. A rational risk-neutral consumer's response in a market wherein a firm engages in confidential settlements may be to reduce demand. A firm committed to openness incurs higher liability and R&D costs, though product demand is not diminished. We identify conditions such that, if the cost of credible auditing (to verify openness) is low enough, a firm prefers to eschew confidentiality. (*JEL* D82, K13, L15)

What is the effect of secrecy about the existence or extent of product-generated harms on the provision of safe products? Such secrecy naturally arises when firms negotiate and settle lawsuits (filed by harmed product users) with "sealing" orders provided by courts, or private "contracts of silence," that keep everything from initial discovery through the actual details of a settlement secret, under pain of court-enforced contempt citations or damages for breach of contract, respectively.[1] According to attorneys, these practices are widespread and routine in products liability cases.[2] Recent revelations of the past sexual abuse of minors by priests, much of which was concealed by confidential settlements, make clear that this practice is not confined to product markets alone.[3]

We employ a simple two-period model to show that the use of confidential settlement as a strategy for a firm facing tort litigation leads to lower average quality of inputs used, and lower average safety of products sold, than that which would be produced if a firm were committed to openness. Moreover, confidentiality can even cause this latter measure to decline over time. We also show that a rational risk-neutral consumer's response to a market environment, wherein a firm engages in confidential settlement agreements, may be to reduce demand. Finally, we discuss how firm profitability is influenced by the decision to have open or confidential settlements; all else equal, a firm following a policy of openness will incur higher liability and R&D costs, though

product demand will not be diminished (as it may be for a firm employing confidentiality). Moreover, an open firm may face costs of making the commitment to openness credible.[4]

The extensive provision of secrecy by courts is becoming, both for the states and the federal government, an important policy issue. For some time, approximately one-fifth of the states (and the federal government) have been considering eliminating or severely restricting confidentiality, though the focus of such "sunshine" laws tends to be only about conditions that significantly endanger public health and safety (leaving much of products liability untouched). Recently all federal judges in one state (South Carolina) agreed to no longer provide confidentiality in "everything from products liability cases to child-molestation claims and medical malpractice suits."[5]

The legal literature on confidentiality is quite large; for a discussion of some of the (conflicting) legal issues, see Lloyd Doggett and Michael J. Mucchetti (1991), Arthur R. Miller (1991), Garfield (1998), Laurie K. Doré (1999) and Blanca Fromm (2001). There are basically three arguments made by those desiring elimination of confidentiality and three arguments made by those in favor of continuing to allow confidentiality. Those favoring eliminating confidentiality stress the benefits to third parties: 1) other injured people who have not realized they may have a cause of action (both consumers who bought the product and were harmed, as well as non-consumers harmed by externalities, such as occur in second-hand smoke or toxic chemical spills) will realize that they have a case; 2) further risks to health and safety will be averted; and 3) discovery sharing among plaintiffs harmed by the same product (which might improve the viability of plaintiffs' cases, or reduce the costs associated with pursuing a suit) will be facilitated.[6] Those favoring continuing to allow confidential settlements argue that: 4) discovery sharing is likely to inspire nuisance suits;

5) important privacy interests of the parties, such as protecting trade secrets or highly personal information, will be protected; and 6) many settlements are made contingent upon sealing (promoting settlement is an important goal of the civil justice system; see Federal Rule of Civil Procedure 16(a), Stephen C. Yeazell, 1996).

A. *Related Literature*

This paper naturally fits into (and bridges) two literatures, namely that concerned with signaling product quality via price, and that concerned with confidentiality and bargaining. Previous papers in which a monopoly signals quality via price include Kyle Bagwell and Michael H. Riordan (1991), Bagwell (1992) and Andrew F. Daughety and Jennifer F. Reinganum (1995).[7] This paper abstracts from competitive considerations such as entry or the presence of other firms, as well as advertising and other non-price avenues for signaling, but expands the quality signaling model to consider a continuum type-space which is endogenously determined by the firm's decision to retain or replace an input. It is closest to Daughety and Reinganum (1995), since (as there) the post-market-transaction continuation game reflects the firm's liability for harms due to its choices regarding safety provision.

The economics literature concerned with confidentiality and bargaining is much smaller. Bill Z. Yang (1996) briefly discusses exogenously-determined regimes of confidentiality or openness and their effect on sequential bargaining by a defendant with a series of plaintiffs. Daughety and Reinganum (1999, 2002) also consider a sequence of settlement bargaining games, but model bargaining as being over both money and the choice of confidentiality versus openness. Thomas H. Noe and Jun Wang (2004) provide a model of confidentiality in sequential negotiations in which a buyer faces a sequence of sellers. They show that, when the items to be purchased are

sufficiently complementary, it is profitable for the buyer to randomize the order in which he approaches the sellers, and to keep secret this order and the outcome of previous negotiations.

None of the above analyses connects the presence or absence of confidentiality to the endogenous determination of product safety, which we do here. We show that commitment to a particular informational regime (confidentiality versus openness) influences a firm's downstream incentives to improve safety and a consumer's willingness to purchase the product. We characterize the choice of regime, providing conditions such that, if the cost of credible auditing (to verify openness) is low enough, a firm will choose to pay for the auditing and eschew confidentiality. Thus, if society were to ban (or substantially limit) the use of confidential settlements, then under the relevant conditions, a firm would prefer this (as the cost of credible auditing would then be zero). However, there may be conditions under which even free auditing would not make a firm prefer openness, in which case it would prefer that the law allow confidential agreements.

B. *Plan of the Paper*

In Section I the model set-up, structure and notation are detailed. In Section II we characterize the equilibrium under openness or confidentiality, while Section III compares the equilibria for the two regimes. Section IV examines the endogenous choice of regime. The analysis of these sections is under a parametric restriction that guarantees the existence of a (unique) revealing equilibrium; Section V provides the essential results when only a pooling equilibrium exists. Section VI summarizes the results and discusses the policy implications of banning or allowing confidentiality. Formal statements of the equilibria are in the Appendix while proofs, derivations and supplementary material are provided in a Web Appendix.[8]

I. Model Set-Up, Structure and Notation

We consider a two-period model of a firm producing a product with a safety attribute. Within each period, three distinct interactions occur. First, a firm chooses an input whose quality affects the safety of its product. Second, the firm chooses a price, which affects the purchasing decisions of consumers. Third, the firm engages in settlement negotiations with consumers who are harmed by the product.   Prior to the start of Period 1, we assume that the firm has an opportunity to choose the regime under which it will conduct its settlement negotiations: the settlements are confidential (denoted C) unless the firm has committed itself to a regime of openness (denoted O). Commitment to a regime of openness will require a fixed expenditure on external monitoring.

We describe each of these interactions, and the linkages between them both within and across periods, in turn. We begin by defining some notation that will be common to the two periods, and then we specify the timing and the information structure of the model. We will indicate parameters which are assumed to vary with the regime by a superscript "i," where $i = O$ or C.

A. *Notation*

Let θ denote the quality of an input, such as a production technology. We also identify θ with the safety of a unit of the product produced by this technology, and interpret θ as the probability that the consumer uses the product without incident; that is, θ is the probability that the product does not cause harm. We will also typically refer to θ as the technology's, the firm's, or the product's "type." Assume that θ is distributed according to a continuously differentiable distribution function, $G(\bullet)$, with positive density, $g(\bullet)$, on the interval $[\underline{\theta}, \bar{\theta}]$. Let $\mu \equiv E(\theta)$ be the expected value of θ.

We assume that the technology can also be employed in alternative activities for the firm, should it not be fully-utilized in producing the primary product, which may generate a second

product or revenue stream for the firm. In this alternative use, the technology generates profits for the firm that are proportional (at the rate β) to its quality.[9] We assume that the firm makes more profit when it produces the primary product, so the firm will only engage in the alternative activity when consumer demand falls short of its capacity, which we denote by N.[10] Initial acquisition of the technology, or its subsequent replacement, occurs at a cost denoted t. For simplicity, we assume there are no other costs associated with producing the product.

Let V denote the value of consumption of one unit of the product. We assume that there are N consumers (so the technology provides the capacity to serve the entire market), and that each consumer demands at most one unit. Let the prevailing price for Period j be denoted p_j, for $j = 1$, 2. In order to determine her willingness to pay for the product, the consumer must form expectations (or beliefs, depending upon the information available to her) about the likelihood that she will be harmed by the product, and the associated losses she will bear.

In order to focus on other issues, we assume a simple litigation subgame structure. In particular, suppose that it is common knowledge that each harmed consumer (each plaintiff, denoted P) suffers an injury in the amount δ.[11] Under the assumption that the firm (the defendant, denoted D) is strictly liable for the harms it causes, this is the amount of damages P would receive if successful at trial.[12] However, merely knowing that one has been harmed by use of a product is not sufficient to be successful at trial; rather, convincing evidence of causation is required, even under strict liability. We assume that there is a probability, denoted λ^i, that a consumer will be able to provide convincing evidence. With the complementary probability other intervening factors may cloud the relationship between product use and harm, undermining the viability of the consumer's case. We index the likelihood of a viable case by the regime to indicate that confidential versus

open settlement may affect the likelihood that a case is viable. In particular, we assume that $\lambda^C \leq$ λ^O; that is, one effect of confidential settlement (which usually results in a blanket gag order) is that it prevents plaintiffs from learning about each other's cases and possibly sharing information that might improve the viability of their cases (see Hare, et al., 1988; they argue that this is an important reason for defendants to seek confidentiality). Moreover, we assume that when a consumer complains of harm to the firm, it is common knowledge (between the parties) whether the consumer's case is viable or not. Thus, plaintiffs with non-viable cases receive nothing, while plaintiffs with viable cases receive a settlement. We assume that the amount of the settlement is provided by finding the Nash Bargaining Solution to a complete information game, taking into account the parties' relevant costs of settlement versus trial.[13]

We are assuming here that compensation is determined by the tort system, rather than by *ex ante* contracting between the firm and a consumer. In the case of injury, a firm cannot limit its liability for a consumer's harm through contractual means. Under the penalty doctrine, the common law does not enforce stipulated damages in excess of expected damages (Samuel A. Rea, Jr., 1998, p.24). Thus, the maximum value of enforceable stipulated damages would be δ. But then, assuming that the firm cannot commit not to dispute causation (that is, the consumer would still have to be able to prove that the firm's product caused the consumer's harm in order to have the contract enforced), the consumer's expected loss would be unchanged.

Let k_{SP} and k_{SD} denote the costs of negotiating a settlement for P and D, respectively, and let k_{TP} and k_{TD} denote the incremental costs of trial for P and D, respectively. Since most product liability suits involve a plaintiff's attorney being paid a contingency fee, k_{SP} is actually likely to be substantial (from 1/4 to 1/3 of the settlement P receives), while the incremental costs of trial, k_{TP},

may be relatively small. On the other hand, since the defendant is likely to pay his attorney an hourly fee, k_{SD} may be relatively small compared to the incremental cost of trial, k_{TD}. The model, however, allows these costs to take on arbitrary values.

B. *Timing and Information Structure*

Prior to the first period, the firm commits itself to a regime of either open, or confidential, settlement negotiations. A commitment to a regime of openness will require a public expenditure on independent monitoring; failure to make such a costly and visible commitment results in an inference that the firm will engage in confidential settlement.

At the beginning of Period 1, the firm in regime i incurs R&D costs of t to acquire a technology. We assume that the realized value of θ associated with this technology is not observed by the firm until after the product has been sold and consumers begin reporting harm. Thus the firm sets its price p_1 under symmetric, but imperfect, information vis-a-vis the consumer. Consumers make their purchase decisions, and some suffer harm. We assume that all consumers report their harms to the firm, seeking compensation, but only those with viable suits receive settlements. At this point, since harmed consumers are not aware of the totality of the complaints, only the firm is able to construct the realized value of θ.[14]

At the beginning of Period 2, it is now common knowledge that the firm knows the safety of its own product. If the firm is credibly committed to a policy of openness, then consumers can costlessly ascertain the firm's realized first period value of θ. Furthermore, independent of its policy of openness or confidentiality, if the firm chooses to replace its technology with a new one, we assume that this is observable to consumers. If the technology is replaced, then Period 2 plays out the same as Period 1. If the firm chooses to retain its Period 1 technology, then under a regime of

openness, consumers also know the product's second-period safety. However, under a regime of confidentiality, since the consumer is uninformed about the product's continuing level of safety, she is at an informational disadvantage compared to the firm, and takes this into account in her subsequent purchasing behavior. In particular, she draws an inference about product safety from the price p_2 and bases her purchasing decision on this inference. As in Period 1, consumers harmed in Period 2 seek compensation and those with viable cases receive a settlement.

II. Analysis of the Model under Alternative Regimes

We solve the model by backward induction. We first characterize the settlement subgame equilibrium, which is the same for both periods. We then briefly discuss the alternative use of the technology by the firm. Then we characterize equilibrium play in Period 2, and then in Period 1, first under the assumption of an open regime and then under a regime of confidentiality.

A. *Settlement Subgame Equilibrium*

By negotiating and settling rather than going to trial, P (respectively, D) individually spends the amount k_{SP} (respectively, k_{SD}), but they jointly save the amount $K_T \equiv k_{TP} + k_{TD}$. Thus, the resulting Nash Bargaining Solution involves the plaintiff with a viable case receiving a settlement equal to her disagreement payoff, $\delta - k_{SP} - k_{TP}$, plus one-half of the saved incremental trial costs ($K_T/2$). Similarly, the defendant pays his disagreement payoff,[15] less one-half of the saved incremental trial costs, for a resulting payment of $\delta + k_{SD} + k_{TD} - K_T/2$.

Since not all cases are viable, we compute the continuation payoffs for the consumer and the firm, conditional upon the consumer being harmed. A harmed consumer will suffer a loss of δ and receive her settlement payoff if she has a viable case, which occurs with probability λ^i in regime i. Thus, the expected loss borne by a harmed consumer in regime i, denoted L_P^i, is given by $L_P^i = \delta -$

$\lambda^i(\delta - k_{SP} - k_{TP} + K_T/2)$. Similarly, the expected loss borne by the firm when a consumer is harmed in regime i, denoted L_D^i, is given by $L_D^i = \lambda^i(\delta + k_{SD} + k_{TD} - K_T/2)$. We assume that each party bears some loss; that is, $L_P^i > 0$ and $L_D^i > 0$. For simplicity, let L^i denote the combined loss due to consumer harm and settlement costs: $L^i \equiv L_P^i + L_D^i = \delta + \lambda^i K_S$, where $K_S \equiv k_{SP} + k_{SD}$.

<center>B. *Alternative Use of the Firm's Technology*</center>

Recall that the firm can either produce the product with the safety attribute, or engage in alternative productive activities with the same technology. For example, a technology could be used to produce both therapeutic drugs and multi-vitamins. A "better" technology may promote greater safety when used to produce therapeutic drugs, and greater output when used to produce multi-vitamins. The social value of using a technology of type θ to produce a unit of the primary product is $V - (1 - \theta)L^i$, while the social (and private) value of using the technology in an alternative activity is given by $\beta\theta$. We make the following assumption regarding the parameters.

ASSUMPTION 1: *For i = O, C: (a) $V > L^i > \beta$; and (b) $t < (\mu - \underline{\theta})NL^i$.*

Part (a) implies that the net social value, $V - (1 - \theta)L^i - \beta\theta$, is positive for all $\theta \in [\underline{\theta}, \bar{\theta}]$ and increasing in the safety of the product (since $L^i > \beta$). This assumption is actually stronger than is necessary; some product types with negative net social value could be accommodated.[16] Assumption 1(a) also implies that using the technology to produce the primary product is always more valuable (socially) than using it in an alternative activity. Part (b) implies that it is preferable to acquire a new technology of unknown quality rather than to produce with the worst technology. For the analysis in Sections II - IV we will further assume that a marginal increase in the quality of the input, θ, produces greater profits in the alternative activity than it reduces the firm's liability costs in the primary activity. This implies that (for a given price) firms with better technologies are more

willing to use them in the alternative activity than those with worse technologies. Formally, this is captured by the assumption that $\beta > L_D^C$; the alternative case will be taken up in Section V.

Notice that, because each consumer has unit demand and the firm is a monopolist, the firm will extract the full value of the product to the consumer as long as there is symmetric information about θ. Thus, in the case of a new technology (when noone knows θ), all consumers will want a unit of the product at the symmetric-information monopoly price, and the firm's entire capacity will be devoted to producing the product. In addition, in a regime of openness, the consumer and the firm will both know the retained technology's quality. Thus, all consumers will want a unit of the product at the full-information monopoly price and again the firm's entire capacity will be devoted to producing the product. Only in the case of a confidential regime, in which asymmetric information prevails, might the firm employ a portion of its capacity in an alternative activity.

C. *Equilibrium in a Regime of Openness*

We solve the model by backward induction, first characterizing the equilibrium in Period 2 and then in Period 1. Let θ_j denote the quality of the technology in Period j, $j = 1, 2$. If the technology from Period 1 has not been replaced, then it is common knowledge (under an O regime) that $\theta_2 = \theta_1$. In this case, the consumer's maximum willingness to pay for the good is given by $V - (1 - \theta_1)L_P^O$. Thus, the firm will charge $p_2 = V - (1 - \theta_1)L_P^O$ and each consumer will buy one unit. In this case, since the firm's capacity is exhausted by the demand for the primary product, no capacity will be devoted to the alternative use. Thus, the firm's continuation profit from retaining a technology of type θ_1, denoted $\Pi_2^O(r; \theta_1)$, is given by: $\Pi_2^O(r; \theta_1) \equiv N[V - (1 - \theta_1)L_P^O - (1 - \theta_1)L_D^O]$ $= N[V - (1 - \theta_1)L^O]$. Notice that, because the consumer adjusts her willingness to pay to account for her potential downstream losses, the firm faces the full loss L^O.

If the technology has been replaced, then it is common knowledge that neither the firm nor the consumer knows the true value of θ_2. In this case, the consumer's maximum willingness to pay for the good is $V - (1 - \mu)L_P^O$. The firm will set $p_2 = V - (1 - \mu)L_P^O$ and each consumer will buy one unit. The firm's continuation profit from acquiring a new technology, denoted $\Pi_2^O(n)$, is given by:

$$\Pi_2^O(n) \equiv N[V - (1 - \mu)L_P^O - (1 - \mu)L_D^O] - t = N[V - (1 - \mu)L^O] - t.$$

In making its retention decision at the beginning of Period 2, the firm compares $\Pi_2^O(r; \theta_1)$ to $\Pi_2^O(n)$, and retains the Period 1 technology whenever $\Pi_2^O(r; \theta_1) \geq \Pi_2^O(n)$; that is, whenever:

(1) $\qquad \theta_1 \geq \theta^O \equiv \mu - t/NL^O.$

Given this retention rule, the firm's expected continuation profits from the beginning of Period 2 are:

(2) $\qquad E\Pi_2^O \equiv \{N[V - (1 - \mu)L^O] - t\}G(\theta^O) + \int^O N[V - (1 - \theta_1)L^O]g(\theta_1)d\theta_1,$

where $\int^O$ indicates that the domain of integration is $[\theta^O, \bar{\theta}]$.

The analysis of Period 1 is quite straightforward, since this period looks exactly like Period 2 when the firm acquires a new technology. Thus, the firm's profit from Period 1 on (that is, the two-period profit under the O regime, gross of any monitoring costs it must pay to credibly commit to O), denoted Π_1^O, is given by:

(3) $\qquad \Pi_1^O \equiv N[V - (1 - \mu)L^O] - t + E\Pi_2^O.$

D. *Equilibrium in a Regime of Confidentiality*

Again, we begin with Period 2. A sketch of the derivation of a revealing perfect Bayesian equilibrium and a formal statement are in the Appendix while the proof is in the Web Appendix. Recall that in a regime of confidentiality, information regarding Period 1 suits is not observable to consumers in Period 2, as it has been suppressed through the use of confidentiality agreements.[17] Thus, if the technology has been retained, Period 2 consumers need to form beliefs about the

product's safety based on choices made by the firm that are observable to Period 2 consumers. These are (1) the firm's decision to retain the technology, and (2) the firm's choice of price for Period 2.

We assume that, upon observing that the firm has retained the technology from Period 1, consumers believe that the firm's type belongs to an interval $[\Theta, \bar{\theta}]$; that is, the marginally-retained technology is of type Θ. Thus, consumers believe that the firm would have retained the technology if its quality were sufficiently high. Moreover, upon observing that the firm is charging p_2, consumers believe that the firm's type is $b(p_2; \Theta)$. Since we will be characterizing a revealing equilibrium, we employ "point beliefs" by specifying that b is a singleton rather than a set. In a revealing equilibrium, the beliefs $b(\bullet; \Theta)$ will be correct, as will the conjectured value of Θ.

Since each firm would be tempted to inflate its price (if the consumer were to purchase a unit for sure at every price), the consumer must respond to higher prices with increasing "wariness." That is, the consumer must confront higher prices with a lower probability of concluding a sale. Let $s(p_2; \Theta)$ denote the probability of a sale when the firm charges p_2, given the conjectured value of Θ. The firm's continuation payoff from retaining a technology of type θ_1, denoted $\Pi_2^C(r; \theta_1, \Theta)$, is:

(4) $\Pi_2^C(r; \theta_1, \Theta) \equiv \max_{p_2} Ns(p_2; \Theta)[p_2 - (1 - \theta_1)L_D^C] + N(1 - s(p_2; \Theta))\beta\theta_1.$

The firm uses $Ns(p_2; \Theta)$ units of capacity to produce the primary product, and the remaining units of capacity on the alternative activity, where each capacity unit yields a payoff of $\beta\theta_1$.

There are two critical aspects of the revealing perfect Bayesian equilibrium (derived in the Appendix) which we note here. First, the revealing equilibrium price is the full-information price $p_2^*(\theta_1) \equiv V - (1 - \theta_1)L_P^C$. Second, the equilibrium probability of a sale can be written in reduced form as a function of the firm's type, θ_1, and the consumer's beliefs about the marginally-retained

technology, Θ, as:

(5) $s^*(\theta_l; \Theta) = \{[V - (1 - \Theta)L^C - \beta\Theta)]/[V - (1 - \theta_l)L^C - \beta\theta_l)]\}^\alpha$,

where $\alpha \equiv L_P^C/(L^C - \beta) > 1$ under our maintained assumption that $\beta > L_D^C$.

Observe what $s^*(\theta_l; \Theta)$ entails. First, consider the ratio inside the braces. The numerator is the net social value associated with one unit produced by the marginally-retained type of technology; this is also the net unit profit for the firm's product (since welfare and profit are the same for this unit-demand analysis). Likewise, the denominator is the net unit profit for the firm's product for a retained technology of type $\theta_l > \Theta$. Thus, this ratio is a fraction, the purpose of which is to reduce the incentive for mimicry of high-type firms by low-type firms. However, what the analysis tells us is that this degree of wariness by the consumer is not sufficient to deter mimicry. The exponent, α, which is $L_P^C/(L^C - \beta)$, reflects both the losses borne by the consumer (and greater losses should make her more wary) as well as the degree of sensitivity of the firm to the consumer's means for responding to price increases. Higher β means that the firm's alternative use of the technology is proportionally more profitable, making the loss of a sale in response to a price increase less costly. Recognizing this means that the consumer must be yet more wary. This is why α, which is greater than one, further amplifies the effect of the ratio inside the braces, so as to further deter mimicry. Since this is the unique revealing equilibrium, the resulting response by the consumer is both necessary and sufficient to achieve revelation in equilibrium. As will be seen in Section V, if β is too low ($\beta < L_D^C$), then higher types of the firm will be overly-sensitive to the loss of sales due to a price increase (which would reveal their higher safety), and pooling will result.

We can re-write the firm's continuation profits as:

$\Pi_2^C(r; \theta_l, \Theta) = Ns^*(\theta_l; \Theta)[p_2^*(\theta_l) - (1 - \theta_l)L_D^C] + N[1 - s^*(\theta_l; \Theta)]\beta\theta_l$,

where $s*(\theta_I; \Theta)$ is as given in equation (5). The equilibrium profits are increasing in θ_I; that is, firms with safer products (equivalently, higher-quality technologies) make higher profits, despite the fact that they face demand withdrawal from wary consumers.

Since firm profits are increasing in type, the form of the consumer's beliefs about retention is confirmed: firms with higher-quality technologies will retain them, while firms with sufficiently low-quality technologies will replace them. If the technology was replaced rather than retained, then it is common knowledge that neither the firm nor the consumer knows the true value of θ_2. Analogously to this case in the O regime, the consumer's maximum willingness to pay for the good is $V - (1 - \mu)L_P^C$, the firm sets $p_2 = V - (1 - \mu)L_P^C$ and each consumer buys one unit. The firm's continuation profit from acquiring a new technology is: $\Pi_2^C(n) \equiv N[V - (1 - \mu)L^C] - t$.

To determine the type of the worst technology retained, we need to find θ^C such that if the consumer conjectures that θ^C is the worst type of technology retained, then the firm must be indifferent between retaining and replacing that type. Since $s(p_2^*(\theta^C); \theta^C) = 1$, the retention profit is $\Pi_2^C(r; \theta^C, \theta^C) = N[V - (1 - \theta^C)L^C]$. Setting this equal to the replacement profit $\Pi_2^C(n)$ and solving for θ^C yields:

(6) $\theta^C \equiv \mu - t/NL^C$.

Thus, under confidentiality, the firm retains the technology if $\theta_I \geq \theta^C$, and otherwise replaces it.

Upon substituting $\Theta = \theta^C$ into equation (5), we can finally write the reduced-form equilibrium probability of a sale as a function of firm type θ_I as follows:

(7) $s*(\theta_I; \theta^C) = \{[V - (1 - \theta^C)L^C - \beta\theta^C]/[V - (1 - \theta_I)L^C - \beta\theta_I]\}^{\alpha}$.

The function $s*$ is decreasing (and convex) in θ_I; moreover, it is increasing in V, N and μ and decreasing in β and t (see the Web Appendix). Since a product with a higher realized safety (θ_I)

signals this via setting a higher price, and higher prices are met with greater wariness on the part of consumers, the probability of a sale is lower for a product with a higher realized safety. An increase in the value of consumption (*V*) makes the consumer less wary while (as discussed earlier) an increase in the value of the alternative use of the input (β) increases the incentive for low types to mimic high types, thereby increasing the consumer's wariness. The parameters *N*, μ and *t* enter indirectly via the retention threshold θ^C, which is increasing in *N* and μ and decreasing in *t*. Since consumers are less wary when θ^C is higher (since they can then be more confident of higher safety), increases in market size (*N*) and the *ex ante* expected safety (μ) increase the probability of a sale while an increase in *t* reduces the probability of a sale. Revealing equilibria do not normally depend on the distribution function (here, *G*), but only on the support (here, $[\underline{\theta}, \bar{\theta}]$). However, in this case the consumer's beliefs about the support have been updated (i.e., the type space is determined endogenously in this model), and the resulting probability of sale function $s^*(\theta_I; \theta^C)$ now depends on other attributes of the distribution (here, the mean μ) through the retention threshold θ^C. The following lemma summarizes the impact of these parameters on the equilibrium probability of a sale.

LEMMA 1. *The equilibrium probability of a sale is higher for a product with a higher value to the consumer, a larger market, or a higher ex ante expected safety level. The equilibrium probability of a sale is lower for a product with a higher realized safety level, a higher input replacement cost, or a higher-valued alternative use of the input.*

Given the retention rule and the equilibrium strategies $p_2^*(\theta_I)$ and $s^*(\theta_I; \theta^C)$, we can write the firm's expected continuation profits from the beginning of Period 2 as:

$$(8) \quad E\Pi_2^C \equiv \{N[V - (1 - \mu)L^C] - t\}G(\theta^C)$$

$$+ \int^C \{Ns^*(\theta_I; \theta^C)[V - (1 - \theta_I)L^C] + N[1 - s^*(\theta_I; \theta^C)]\beta\theta_I\}g(\theta_I)d\theta_I,$$

where $\int^C$ indicates that the domain of integration is $[\theta^C, \bar{\theta}]$. Again, the analysis of Period 1 looks exactly like Period 2 when the firm replaces its technology. Thus, the firm's profit from Period 1 on (in the C regime), denoted Π_1^C, is given by:

(9) $\Pi_1^C \equiv N[V - (1 - \mu)L^C] - t + E\Pi_2^C.$

III. Comparison of the Regimes

In this section, we compare the O and C regimes' *ex ante* performance in terms of the average quality of the technology in Period 2, the average safety of products sold in Period 2, the volume of trade in Period 2, and the time path of the average safety of products sold. Recall that the retention threshold in regime i is given by $\theta^i \equiv \mu - t/NL^i = \mu - t/N(\delta + \lambda^i K_S)$; thus $\theta^C < (=) \theta^O$ as $\lambda^C < (=) \lambda^O$. Proposition 1 summarizes the effect of confidentiality on the decision to replace the technology and the expected costs of R&D.

PROPOSITION 1: *The technology retention threshold, and the associated expected R&D investment, are lower under a confidential regime than under an open regime. That is, some inputs that would have been replaced under an open regime are retained under a confidential regime.*

The expression $E(\theta_2; \theta^i) \equiv \mu G(\theta^i) + \int^i \theta g(\theta)d\theta$, where the domain of integration is $[\theta^i, \bar{\theta}]$, denotes the average quality of the technology in Period 2 under regime i. Since $\theta_2 = \theta_1$ when the technology is retained, this can be re-written as $E(\theta_2; \theta^i) = \mu + h(\theta^i)$, where $h(\theta^i) \equiv \int^i(\theta_1 - \mu)g(\theta_1)d\theta_1$. Notice that $h(\underline{\theta}) = 0$ and $h'(\theta^i) > 0$ (and therefore that $h(\theta^i) > 0$) for all $\theta^i < \mu$. Since $\theta^C < \theta^O < \mu$, it follows immediately that the average quality of the technology employed is above the mean in both regimes ($E(\theta_2; \theta^i) > \mu$, $i = C, O$) but that average quality is lower under confidentiality than under openness: $E(\theta_2; \theta^C) < (=) E(\theta_2; \theta^O)$ as $\lambda^C < (=) \lambda^O$. The following proposition summarizes the average quality of the technology both within-regime but across periods,

and within-Period 2 but across regimes.

PROPOSITION 2: *The average quality of the technology improves from Period 1 to Period 2.*

However, the average quality of the technology in Period 2 is lower in a confidential regime than

in an open regime.

A similar question can be asked regarding the average safety of products sold (that is, the

quality-weighted number of units sold). This is an interesting measure because it reflects any

changes in sales volume and the change in the composition of sales (that is, how many of each type)

occasioned by the informational regime. In an open regime, this measure in Period 2 is simply N

times the average quality of the technology in Period 2. Let $\sigma(\theta_2; \theta^O) = N\mu$ if $\theta_1 < \theta^O$ and $\sigma(\theta_2; \theta^O)$

$= N\theta_1$ if $\theta_1 \geq \theta^O$; then $E(\sigma, \theta^O) = N\mu + Nh(\theta^O)$. This measure is more complicated in a C regime

since consumers respond to asymmetric information by being wary of purchasing (i.e., reducing the

likelihood of a sale). Let $\sigma(\theta_2; \theta^O) = N\mu$ if $\theta_1 < \theta^C$ and $\sigma(\theta_2; \theta^C) = N\theta_1 s^*(\theta_1; \theta^C)$ if $\theta_1 \geq \theta^C$. Then

$E(\sigma, \theta^C)$ is the average safety of products sold in Period 2 in a C regime, where $E(\sigma, \theta^C) = N\mu G(\theta^C)$

$+ \int^C N\theta_1 s^*(\theta_1; \theta^C)g(\theta_1)d\theta_1$. It is then straightforward to show that the average safety of products

sold is lower under confidentiality: $E(\sigma, \theta^C) < E(\sigma, \theta^O)$. The effect of confidentiality on the

average safety of products sold in Period 2 is summarized below.

PROPOSITION 3: *The average safety of products sold in Period 2 is lower in a confidential regime*

than in an open regime.

This result holds even if confidentiality does not reduce case viability (that is, even if $\lambda^C =$

λ^O). This is because there are two reasons why confidentiality reduces the average safety of

products sold in Period 2. First, if confidentiality does reduce case viability ($\lambda^C < \lambda^O$), then the

average quality of technology will be lower in Period 2 under confidentiality (as compared to

openness), so if a unit were sure to be produced, it would be of lower average safety. But even if $\lambda^C = \lambda^O$ (so that retention thresholds, R&D expenditures and the average quality of technology in Period 2 are the same for the two regimes), the average safety of products sold in Period 2 will still be lower in a confidential regime due to consumer wariness, since the equilibrium probability of a sale is lower for safer products (since they have higher prices).

Indeed, rational consumer wariness can be so extreme that the average safety of products sold in a confidential regime can actually <u>decrease</u> from Period 1 to Period 2. To ascertain parameter combinations (in terms of V and t/N) under which this is likely to occur, first note that $E(\sigma, \theta^C) < N\mu$ if and only if $H(V, t/N) \equiv \int^C [\theta_I s^*(\theta_I; \theta^C) - \mu] g(\theta_I) d\theta_I < 0$. $H(V, t/N) = 0$ is the locus of parameters such that the average safety of products sold is constant across periods. It can be shown that this curve is monotonically increasing (that is, $\partial H/\partial V > 0$ and $\partial H/\partial(t/N) < 0$; see the Web Appendix), so it follows that the average safety of products sold is more likely to decline from Period 1 to Period 2 when V is low, or when t/N is high. Figure 1 below displays an example (further examples are provided in the Web Appendix) wherein G is the uniform distribution, the range of θ is the unit interval, and we have normalized V and t/N by the social loss L^C. Parameter values above the curve result in a decline in the average safety of products sold over the two periods as the per-consumer cost of replacing the input, t/N, is high when compared with the per-consumer value of the good, V. The point of the figure is that a significant portion of the parameter space can be associated with declining average safety of products sold.

Moreover, computational examples (see the Web Appendix) further suggest that a mean-preserving spread in the distribution G results in a smaller region of declining average quality of

t/NL^C

0.5

0.4   declining

0.3

0.2   improving

0.1

0

   1   1.5   2   2.5   3
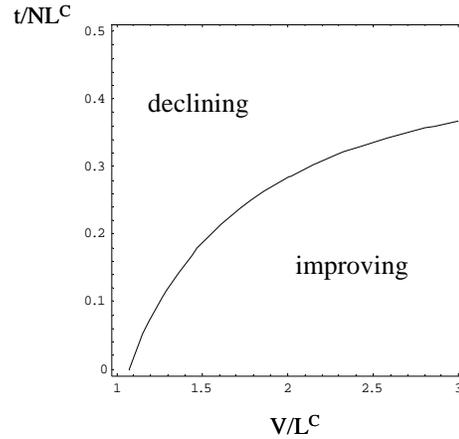
V/L^C

Figure 1: Regions of Declining and Improving
                Intertemporal Equilibrium Average Safety
                of Products Sold Under Confidentiality.

products sold. This is consistent with the intuition that a mean-preserving spread results in more

realized values of input quality θ_I falling below the retention threshold and being replaced with a

new input (which has a higher *ex ante* mean quality).

IV. The Firm's Choice of Regime

In this section, we compare the firm's profitability under an open versus a confidential

regime. In particular, we ask when a firm would find it profitable to eschew confidentiality in favor

of a regime of openness; we will also consider additional factors that affect this choice.

We re-write the firm's *ex ante* expected profits in the open regime as a function of the case-

viability parameter λ^O. *Ex ante* expected profits in an open regime, gross of any monitoring costs

required to ensure credible commitment to openness, are:

(10) $\Pi_I^O(\lambda^O) = \{N[V - (1 - \mu)L^O] - t\}(1 + G(\theta^O)) + \int^O N[V - (1 - \theta_I)L^O]g(\theta_I)d\theta_I.$

Ex ante expected profits in a confidential regime (suppressing λ^C, which is held fixed) are:

(11) $\Pi_I^C = \{N[V - (1 - \mu)L^C] - t\}(1 + G(\theta^C))$

$$+ \int^C \{Ns^*(\theta_I; \theta^C)[V - (1 - \theta_I)L^C] + N[1 - s^*(\theta_I; \theta^C)]\beta\theta_I\}g(\theta_I)d\theta_I.$$

An open regime involves both costs and benefits relative to a confidential one. The costs of adopting an open regime involve paying more settlements (due to a higher fraction of viable suits), as well as higher R&D costs (due to more frequent replacement of the technology) as compared to a confidential regime. In addition, a public expenditure is required to engage in a credible commitment to openness. On the other hand, a firm adopting a regime of openness need not deal with wary consumers, which is a benefit relative to a confidential regime.

Let $M(\lambda^O) \equiv \Pi_I^O(\lambda^O) - \Pi_I^C$ represent the maximum amount that a firm would be willing to pay in order to make a credible commitment to openness. Thus, when non-negative, $M(\lambda^O)$ represents the firm's demand for credible openness. When confidentiality is ineffective in reducing case viability (that is, $\lambda^O = \lambda^C$), then $L^O = L^C$ and $\theta^O = \theta^C$, then the maximum willingness-to-pay is $M(\lambda^C) = \int^C \{N[1 - s^*(\theta_I; \theta^C)][V - (1 - \theta_I)L^C - \beta\theta_I]\}g(\theta_I)d\theta_I$. This expression is clearly positive; thus, when openness does not increase the fraction of viable suits in comparison with confidentiality, the firm would be willing to pay $M(\lambda^C) > 0$ to ensure a credible commitment to openness (e.g., to hire an external auditor). As shown in the Web Appendix, $M'(\lambda^O) < 0$ and $M''(\lambda^O) > 0$. While $M(\lambda^O)$ may remain positive for all $\lambda^O \in [\lambda^C, 1]$, it might also become negative for sufficiently high λ^O. These properties of $M(\lambda^O)$ are summarized below in Proposition 4.

PROPOSITION 4: *If confidentiality is not effective in reducing case viability, then a firm would be willing to pay a positive amount for a credible commitment to openness. However, this willingness to pay declines (but at a declining rate) as confidentiality becomes more effective. Furthermore, it may become zero (or negative) when confidentiality is sufficiently effective in reducing case viability.*

Figure 2 below illustrates two cases. The case in which a firm's willingness-to-pay $M(\lambda^O)$ remains positive for all $\lambda^O \in [\lambda^C, 1]$ is illustrated using a solid line, while the case in which $M(\lambda^O)$ eventually falls below zero is illustrated using a dashed line; in this case, let $\hat{\lambda}$ be such that $M(\hat{\lambda}) = 0$. If the actual cost of credible monitoring, denoted m, is less than $M(\lambda^O)$, then the firm itself will
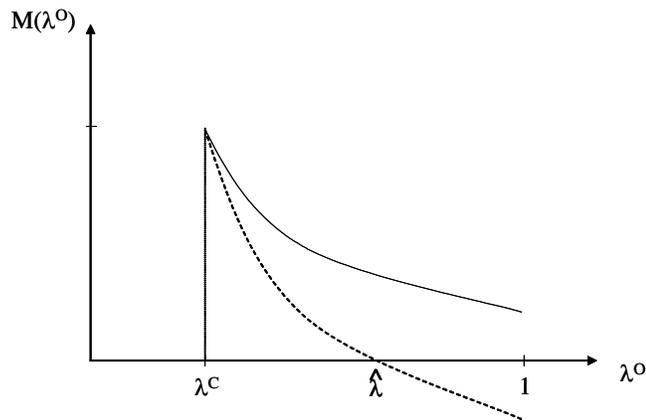

Figure 2: Maximum Willingness to Pay for
Credible Commitment for Openness

choose an open regime. If $m > M(\lambda^O) > 0$, then the firm would prefer a regime of openness (if monitoring were costless), but is unwilling to pay the required amount. Finally, if $M(\lambda^O) < 0$, then the firm would prefer a confidential regime, even if credible monitoring were costless.

A. *The Impact of Loss-Shifting on the Choice of Regime*

In either regime, the firm currently faces an expected loss of L_D^i for each harmed consumer, while the consumer herself faces an expected loss of L_P^i if harmed by the product. The combined losses are $L^i = \delta + \lambda^i K_S$. One variation of interest would be to shift some of the firm's losses to the consumer, holding total losses constant. For instance, recently-imposed limits on compensatory damages for pain and suffering would have this effect. While the expected harm remains unchanged, the expected award is reduced by the caps.

If some of the firm's losses were shifted to the consumer, while total losses were held constant, then the firm's equilibrium profits in an O regime, $\Pi_I^O(\lambda^O)$, would be completely unchanged, since it depends on the losses only through L^O, which is being held fixed. On the other hand, the firm's equilibrium profits in a C regime (Π_I^C) depend upon both L^C, which is being held fixed, and on L_P^C, through the exponent in $s^*(\theta_I; \theta^C)$, which was denoted by α. Thus, to determine the effect on the firm's demand for credible openness of a shift of losses from D to P, holding total losses fixed, we need only determine the sign of $-\partial\Pi_I^C/\partial\alpha$. Differentiating equation (11) with respect to $\alpha = L_P^C/(L^C - \beta)$, holding L^C fixed, yields:

(12) $\quad -\partial\Pi_I^C/\partial\alpha = -\int^C N(\partial s^*(\theta_I; \theta^C)/\partial\alpha)[V - (1 - \theta_I)L^C - \beta\theta_I]g(\theta_I)d\theta_I.$

The integrand is negative for all $\theta_I \in (\theta^C, \bar{\theta}]$, since $\partial s^*(\theta_I; \theta^C)/\partial\alpha < 0$. Thus, an increase in L_P^i, holding L^i fixed (i.e., an increase in α), increases the firm's willingness-to-pay. A firm is willing to pay more for openness as L_P^C increases because this shift of losses to consumers makes them more wary, and the further reduction in their purchases (in a C regime) makes confidentiality less appealing. Alternatively, a shift of losses from P to D (through shifting of settlement costs or awarding multiple damages) will reduce consumer wariness and thus make confidentiality more attractive to the firm.

B. *Impact of Liability for Third-Party Harms on the Firm's Choice of Regime*

If a product is subject to failure, causing harm, it need not harm only those who purchased the product. Often there will be innocent bystanders or other third parties who are also harmed. For instance, when a defective gun misfires, both the user and nearby individuals are at risk. Similarly, when a defective part in an automobile fails, the resulting crash may injure both the driver and third parties (passengers, people in other vehicles, pedestrians). According to tort law for products

liability, "... the courts have almost unanimously allowed recovery for bystanders where injury to them is reasonably foreseeable, ..." (See W. Page Keeton, et. al., 1989, p. 179).

We could define parameters for third-party victims that are analogous to δ and λ^i, which would result in expressions analogous to L_P^i, L_D^i and L^i, but this complicates the exposition unnecessarily. Rather, we will assume that these parameters are the same for consumer victims and third-party victims, and we will simply assume that the consumption of one unit by a consumer exposes an additional ϕ individuals to the same risk of harm. This interpretation allows us to simply substitute $\tilde{L}_D^i = (1 + \phi)L_D^i$ into the profit functions. The consumer still faces the same L_P^i, so $\tilde{L}^i \equiv L_P^i$ $+ \tilde{L}_D^i = L_P^i + (1 + \phi)L_D^i$. Moreover, each of the ϕ individuals per consumer also faces a loss of L_P^i, which does not get transmitted back through the market or the legal system to the firm. Thus, we can conclude immediately that $\partial\theta^i/\partial\phi > 0$; an increase in third-party exposure increases the retention threshold. However, since the uncompensated losses borne by the third parties are not reflected in market prices or firm liability costs, the retention threshold increases less than it should. Note that, in order to preserve the existence of a revealing equilibrium, we now must have $\beta > \tilde{L}_D^C$.

We can now write the firm's maximum willingness to pay for a credible commitment to openness as $M(\lambda^O; \phi) \equiv \Pi_I^O(\lambda^O; \phi) - \Pi_I^C(\phi)$ and ask how an increase in greater liability for third-party losses (analyzed as an increase in ϕ) affects the firm's preference between the O and C regimes. First note that $M(\lambda^O; \phi)$ is of the same form as before (except that L^i and L_D^i have been replaced by $\tilde{L}^i$ and $\tilde{L}_D^i$). Thus, for any fixed value of ϕ the graph of $M(\lambda^O; \phi)$ looks similar to that displayed in Figure 2.

While we are unable to determine the sign of $\partial M(\lambda^O; \phi)/\partial\phi$ for all values of λ^O, we can provide sufficient conditions for $\partial M(\lambda^O; \phi)/\partial\phi < 0$ for λ^O sufficiently close to λ^C.[18] Under this

condition, $\partial s^*(\theta_I; \theta^C)/\partial\phi \geq 0$ for all θ_I; that is, an increase in the firm's liability costs associated with third-party harms permits the consumers to moderate their wariness. Essentially, incentives for the firm to reveal its type come from two sources: lawsuits (either from consumers or third parties) and demand reduction on the part of consumers. When the firm faces higher costs of dealing with third parties' lawsuits, the consumers need not engage in as much demand reduction; they can "free ride" on the third-party lawsuits. This reduction in consumer wariness increases the firm's sales in a *C* regime, making confidentiality more profitable, at least for λ^O in a neighborhood of λ^C.

V. Analysis of the Confidential Regime when $\beta < L_D^C$

In the interests of brevity, we now report on the case of $\beta < L_D^C$, wherein a revealing equilibrium fails to exist (See Claim 2 in the Appendix; complete details of this analysis, and associated proofs, are provided in the Web Appendix). Let $\mu(\Theta) \equiv \int\theta_I g(\theta_I)d\theta_I/(1 - G(\Theta))$, where the integration is over $\theta_I \in [\Theta, \bar{\theta}]$, be the expected value of θ_I when the consumer believes $\theta_I \in [\Theta, \bar{\theta}]$. In the pooling case, the consumer's equilibrium beliefs are of the form $\theta_I \in [\theta^{CP}, \bar{\theta}]$, where θ^{CP} equates the firm's profits if the input is retained to those if it replaces the input at a cost of t:

(13) $N[V - (1 - \mu(\theta^{CP}))L_P^C - (1 - \theta^{CP})L_D^C] = N[V - (1 - \mu)L^C] - t.$

Since $N[V - (1 - \mu(\theta^C))L_P^C - (1 - \theta^C)L_D^C] > N[V - (1 - \mu)L^C] - t$, equation (13) implies that the retention threshold when $\beta < L_D^C$ (i.e., in the pooling equilibrium) is <u>yet lower</u> than the retention threshold when $\beta > L_D^C$ (i.e., in the revealing equilibrium); that is, $\theta^{CP} < \theta^C$, and thus, $\theta^{CP} < \theta^O$. All of the previous propositions apply to the pooling case, and the demand for credible openness, $M(\lambda^O)$, is as depicted earlier.

VI. Summary and Policy Implications

We provide a simple model illustrating the tradeoffs facing a firm choosing between a regime

of open versus confidential settlements. Focusing on the revealing equilibrium, we find that an open regime involves higher liability costs and higher R&D costs, while a confidential regime involves consumer wariness, which exacts a cost associated with signaling safety. We identify circumstances under which the firm would be willing to pay for a credible commitment to openness.

Is it reasonable to posit firms paying for independent auditing to guarantee credibility of a commitment to openness? As mentioned in the Introduction, in the GE-Westinghouse competition in large turbine generators in the 1960's and 1970's, GE ended up doing just that: they employed an accounting firm to monitor all contracts and provide independent authority that GE was adhering to an announced "most-favored-customer" policy which gave full rebates to early buyers from any price cuts provided to later buyers. This was the means by which GE and Westinghouse stabilized otherwise intense price competition which repeatedly had involved secret price concessions.[19]

We have taken the liability regime as given (strict liability, in which the firm is allocated the liability for harm caused). However, the use of the court system is costly in this model. In the case of two parties in an open regime, the market would transfer liability even if it were not nominally imposed on the firm, suggesting perhaps that one should not assign liability to the firm. But this is a misleading special case. In the two-party case in a confidential regime, shifting liability to consumers worsens consumer wariness. While the retention decision still reflects the full social costs, the volume of trade will be further reduced. In the three-party case in either regime, the retention threshold is already too low, and would be made worse if the firm bears no liability. Moreover, the effect on the volume of trade in a confidential regime is even worse, since firm liability for third party harms substitutes for consumer wariness; without this liability, consumer wariness would increase. Finally, we note that some markets may involve downward-sloping

demand, in which case the marginal unit produced should reflect the full social costs.

At the beginning of the paper we noted that judges and legislatures are considering banning confidentiality. Both the feasibility and the optimality of banning confidentiality are problematical. In order to truly eliminate confidentiality, courts would have to refuse to seal documents and settlements. In addition, they would have to refuse to enforce private contracts of silence. Otherwise, confidential settlements would simply be pushed into this area of contracts, where they would be subject to even less judicial oversight.[20]

Under what circumstances might it be welfare-improving to ban confidentiality? While our simple model is inadequate to provide a full answer, some suggestive results emerge. Again we focus on the revealing equilibrium for brevity (and some results, which we note below, differ for the pooling equilibrium). For the two-party case, the firm's retention choice is based on full liability costs, so it chooses the correct threshold in both regimes.[21] Moreover, since the firm extracts all the surplus, confidentiality (and the concomitant lower product quality) can be Pareto superior to openness. If the firm's willingness to pay for openness is positive, the firm itself would presumably support a ban on confidentiality, while it would oppose such a ban when it prefers confidentiality.

For the three-party case, the firm's retention choice is not based on full liability costs (since third parties bear uncompensated losses), so the resulting threshold is too low in both regimes. Preferences of the parties are complicated. Third parties always prefer an open regime, conditional on being harmed; they also always prefer an open regime in the pooling equilibrium, and thus confidentiality cannot be Pareto superior in that case. However, in the revealing equilibrium, on an *ex ante* basis, third parties prefer confidentiality when λ^O is close to λ^C. This is because the extent of third party recovery is the same, but consumer wariness in the confidential regime reduces the

exposure of third parties to harm. Third parties' preference for confidentiality occurs in the portion of the parameter space wherein the firm and the consumer (weakly) prefer an open regime. When λ^O is substantially larger than λ^C, it seems likely that third parties will, *ex ante*, prefer openness, yet this is the portion of the parameter space wherein the firm and the consumer (weakly) prefer confidentiality. Thus, confidentiality seems unlikely to be Pareto superior to openness.

Finally, casual observation indicates that, from the perspective of products liability: 1) few (if any) firms commit to openness; and 2) most consumers (if newspaper accounts and recent legislative ire are indicative) are only now becoming aware of confidentiality's widespread use.[22] Increasing awareness of the widespread use of confidentiality suggests that consumers will become more wary. Firms employing confidentiality can then expect to suffer either reduced demand (in the case of the revealing equilibrium), or a lower expected second-period price (in the case of the pooling equilibrium). Thus, firms should increasingly find it preferable to eschew confidentiality, and they could be assisted by the private provision of specialized auditing services, by well-tailored sunshine laws and by increased judicial restraint with respect to issuing protective and sealing orders, all of which would lower the cost of achieving a credible commitment to openness.

APPENDIX

<u>Definition</u>. A <u>perfect Bayesian equilibrium</u> (in a confidential regime) consists of:

(a) beliefs Θ and $b(p_2; \Theta) \subseteq [\Theta, \bar{\theta}]$ for the consumer;

(b) a probability of sale function $s(p_2; \Theta)$ for the consumer; and

(c) a retention threshold θ^C and a price function $p_2^*(\theta_l)$ for retained technologies such that:

(i) $s(p_2; \Theta)$ maximizes the consumer's expected payoff, given her beliefs Θ and $b(p_2; \Theta)$;

(ii) $p_2^*(\theta_l)$ and the retention threshold θ^C maximize the firm's expected payoff, given $s(p_2; \Theta)$; and

(iii) beliefs are correct in equilibrium; that is, $\Theta = \theta^C$ and $b(p_2^*(\theta_l); \theta^C) = \theta_l$ for all $\theta_l \in [\theta^C, \bar{\theta}]$.

<u>Sketch of derivation of $s^*(\theta_l; \Theta)$</u>.

The first-order-condition for the firm's problem is:

(A1) $s'[p_2 - (1 - \theta_l)L_D^C - \beta\theta_l] + s = 0,$

where s' denotes the derivative of $s(p_2; \Theta)$ with respect to p_2. A consumer (who must randomize in a revealing equilibrium) will only be willing to randomize if she is indifferent about buying; that is, if $V - (1 - b(p_2; \Theta))L_P^C - p_2 = 0$. Thus, the revealing equilibrium price must be $p_2 = p_2^*(\theta_l) \equiv V - (1 - \theta_l)L_P^C$. In order to convert equation (A1) to a differential equation in p_2, we can solve for θ_l as a function of p_2 to obtain $\theta_l = (L_P^C - V + p_2)/L_P^C$. Substituting this result into equation (A1) yields an ordinary differential equation for $s(p_2; \Theta)$.

(A2) $s'[p_2(L^C - \beta) + \beta V - \beta L_P^C - VL_D^C] + sL_P^C = 0.$

We also need a boundary condition to select among the family of solutions to the ordinary differential equation (A2). Since the consumer believes that Θ is the worst type that would have been retained, she anticipates strictly positive surplus from any out-of-equilibrium price $p_2 < p_2^*(\Theta) = V - (1 - \Theta)L_P^C$, and thus would buy with probability 1 at such a price.[23] This in turn implies that she

must buy with probability 1 at $p_2^*(\Theta)$ as well for, if she did not, then type Θ could profitably deviate to some $p_2 < p_2^*(\Theta)$. Thus, the appropriate boundary condition is $s(p_2^*(\Theta); \Theta) = 1$. The solution to the ordinary differential equation (A2) through this boundary condition is given by:

(A3) $s(p_2; \Theta) = \{[p_2^*(\Theta)(L^C - \beta) + \beta V - \beta L_P^C - V L_D^C]/[p_2(L^C - \beta) + \beta V - \beta L_P^C - V L_D^C]\}^{\alpha}$,

where $\alpha \equiv L_P^C/(L^C - \beta) > 1$ under our maintained assumption that $\beta > L_D^C$. It can be shown that the function $s(p_2; \Theta)$ is declining and convex in p_2. Upon substituting the firm's optimal price function $p_2^*(\theta_l) = V - (1 - \theta_l)L_P^C$ into equation (A3) and simplifying, we can write the equilibrium probability of a sale as a function of the firm's type. Let $s^*(\theta_l; \Theta) \equiv s(p_2^*(\theta_l); \Theta)$; then we obtain equation (5) in the main text:

$$s^*(\theta_l; \Theta) = \{[V - (1 - \Theta)L^C - \beta\Theta)]/[V - (1 - \theta_l)L^C - \beta\theta_l)]\}^{\alpha}.$$

<u>Claim 1</u>. When $\beta > L_D^C$, then: (a) The following beliefs and strategies provide a revealing perfect Bayesian equilibrium in a confidential regime; and (b) this is the unique perfect Bayesian equilibrium that survives refinement using D1 (see Jeffrey S. Banks and Joel Sobel, 1987, and In-Koo Cho and David M. Kreps, 1987).

(i) Upon observing that the technology was retained, the consumer believes that $\Theta = \mu - t/NL^C$. Upon observing a price $p_2 \in [V - (1 - \Theta)L_P^C, V - (1 - \bar{\theta})L_P^C]$, the consumer believes that θ_l is given by $b(p_2; \Theta) = 1 - (V - p_2)/L_P^C$. Upon observing a price outside this interval, the consumer's beliefs are arbitrary elements of $[\Theta, \bar{\theta}]$.

(ii) The probability of sale function is $s(p_2; \Theta) = \{A/B\}^{\alpha}$, where $A = V - (1 - \Theta)L_P^C + [\beta V - \beta L_P^C - V L_D^C]/[L^C - \beta]$, $B = p_2 + [\beta V - \beta L_P^C - V L_D^C]/[L^C - \beta]$, and $\alpha = L_P^C/(L^C - \beta) > 1$, for $p_2 \in [V - (1 - \Theta)L_P^C, V - (1 - \bar{\theta})L_P^C]$. Note that $A > 0$, $B > 0$ and $B > A$ for all $p_2 \in [V - (1 - \Theta)L_P^C, V - (1 - \bar{\theta})L_P^C]$. For $p_2 < V - (1 - \Theta)L_P^C$, the probability of sale is $s(p_2; \Theta) = 1$ and for $p_2 > V - (1 - \bar{\theta})L_P^C$, the probability of sale is

$s(p_2; \Theta) = 0$.

(iii) The retention threshold is $\theta^C = \mu - t/NL^C$; that is, technologies with $\theta_I < \mu - t/NL^C$ are replaced, while those with $\theta_I \geq \mu - t/NL^C$ are retained. The price function for products produced by retained technologies is $p_2^*(\theta_I) = V - (1 - \theta_I)L_P^C$ for $\theta_I \in [\theta^C, \bar{\theta}]$.

<u>Claim 2</u>. When $\beta < L_D^C$, then any perfect Bayesian equilibrium must involve pure pooling. The following beliefs and strategies provide a perfect Bayesian equilibrium that survives D1. Technically, any price $p_2 \in [V - (1 - \theta^{CP})L_P^C, V - (1 - \mu(\theta^{CP}))L_P^C]$ can be supported as a PBE since upward deviations are inferred to come from type θ^{CP}, and are therefore rejected. However, the PBE specified below is the natural analog of that characterized in Section II.

i) Upon observing that the technology was retained, the consumer believes that $\Theta = \theta^{CP}$, which is defined implicitly (and uniquely) by $N[V - (1 - \mu(\theta^{CP}))L_P^C - (1 - \theta^{CP})L_D^C] = N[V - (1 - \mu)L^C] - t$. Upon observing the price $p_2 = V - (1 - \mu(\theta^{CP}))L_P^C$, the consumer believes $\theta_I \in [\theta^{CP}, \bar{\theta}]$ and is distributed according to $g(\theta_I)/(1 - G(\theta^{CP}))$ on this interval. Upon observing a price $p_2 < V - (1 - \mu(\theta^{CP}))L_P^C$, the consumer may entertain arbitrary beliefs, and upon observing a price $p_2 > V - (1 - \mu(\theta^{CP}))L_P^C$, the consumer believes that $\theta_I = \Theta = \theta^{CP}$.

(ii) The consumer buys with probability one for $p_2 = V - (1 - \mu(\theta^{CP}))L_P^C$, and buys with probability zero for $p_2 > V - (1 - \mu(\theta^{CP}))L_P^C$. The consumer buys according to her beliefs for $p_2 < V - (1 - \mu(\theta^{CP}))L_P^C$ (since she buys for sure at $p_2 = V - (1 - \mu(\theta^{CP}))L_P^C$, no firm type will ever price lower).

(iii) The retention threshold is θ^{CP} as defined above; that is, technologies with $\theta_I < \theta^{CP}$ are replaced, while those with $\theta_I \geq \theta^{CP}$ are retained. The price function for products produced by retained technologies is $p_2^*(\theta_I) = V - (1 - \mu(\theta^{CP}))L_P^C$, for all $\theta_I \in [\theta^{CP}, \bar{\theta}]$.

REFERENCES

Bagwell, Kyle. "Pricing to Signal Product Line Quality." *Journal of Economics and Management Strategy*, Spring 1992, *1*(1), pp. 151-74.

Bagwell, Kyle and Riordan, Michael H. "High and Declining Prices Signal Product Quality." *American Economic Review*, March 1991, *81*(1), pp. 224-39.

Banks, Jeffrey S. and Sobel, Joel. "Equilibrium Selection in Signaling Games." *Econometrica*, May 1987, *55*(3), pp. 647-62.

Boston Globe Investigative Staff. *Betrayal: the crisis in the Catholic Church.* Boston: Little, Brown and Co., 2002.

Cho, In-Koo and Kreps, David M. "Signaling Games and Stable Equilibria." *Quarterly Journal of Economics*, May 1987, *102*(2), pp. 179-221.

Collins, Jeffrey. "South Carolina Takes Step Toward Banning Secret Legal Settlements." New York: Associated Press, September 25, 2002, p. 1.

Daughety, Andrew F. "Settlement," in B. Bouckaert and G. De Geest, eds., *Encyclopedia of law and economics (volume 5).* Cheltenham: Edward Elgar, 2000, pp. 95-158.

Daughety, Andrew F. and Reinganum, Jennifer F. "Product Safety: Liability, R&D and Signaling." *American Economic Review*, December 1995, *85*(5), pp. 1187-206.

_____. "Hush Money." *RAND Journal of Economics*, Winter 1999, *30*(4), pp. 661-78.

_____. "Informational Externalities in Settlement Bargaining: Confidentiality and Correlated Culpability." *RAND Journal of Economics*, Winter 2002, *33*(4), pp. 587-604.

Doggett, Lloyd and Mucchetti, Michael J. "Public Access to Public Courts: Discouraging Secrecy in the Public Interest." *Texas Law Review*, February 1991, *69*(3), pp. 643-89.

Doré, Laurie K. "Secrecy by Consent: The Use and Limits of Confidentiality in the Pursuit of Settlement." *Notre Dame Law Review*, January 1999, *74*(2), pp. 283-402.

Fluet, Claude and Garella, Paolo G. "Advertising and Prices as Signals of Quality in a Regime of Price Rivalry." *International Journal of Industrial Organization*, September 2002, *20*(7), pp. 907-30.

Fromm, Blanca. "Bringing Settlement Out of the Shadows: Information About Settlement in an Age of Confidentiality." *UCLA Law Review*, February 2001, *48*(3), pp. 663-740.

Gale Group. "The Future of Confidential Settlements." *Mondaq Business Briefing*, May 9, 2003.

Garfield, Alan E. "Promises of Silence: Contract Law and Freedom of Speech." *Cornell Law Review*, 1998, *83*(2), pp. 261-364.

Gross, Samuel R. and Syverud, Kent D. "Don't Try: Civil Jury Verdicts in a System Geared to Settlement." *UCLA Law Review*, October 1996, *44*(1), pp. 1-64.

Hare, Francis H.; Gilbert, James L. and Remine, William. H. *Confidentiality orders*. New York: John Wiley and Sons, 1988.

Hay, Bruce L. and Spier, Kathryn E. "Settlement of Litigation," in P. Newman, ed., *The New Palgrave dictionary of economics and the law* (Vol. 3). New York: Stockton Press, 1998, pp. 442-51.

Herrnreiter v. Chicago Housing Authority, 281 F.3d 634, 636-637 (7th Circuit) 2002.

Hertzendorf, Mark N. "I'm Not a High-Quality Firm – But I Play One on T.V." *RAND Journal of Economics*, Summer 1993, *24*(2), pp. 236-47.

Hertzendorf, Mark N. and Overgaard, Per B. "Competition and Advertising Signals: Signaling by Competing Senders." *Journal of Economics and Management Strategy*, Winter 2001,

10(4), pp. 621-62.

Keeton, W. Page; Owen, David G.; Montgomery, James E. and Green, Michael D. *Products liability and safety: cases and materials, second ed.* Westbury, NY: Foundation Press, 1989.

Linnemer, Laurent. "Entry Deterrence, Product Quality: Price and Advertising as Signals." *Journal of Economics and Management Strategy*, Winter 1998, *7*(4), pp. 615-46.

Manual for complex litigation, third. Federal Judicial Center, 1995. Available online at: http://www.fjc.gov/.

Milgrom, Paul and Roberts, John. "Price and Advertising Signals of Product Quality." *Journal of Political Economy*, August 1986, *94*(4), pp. 796-821.

Miller, Arthur R. "Confidentiality, Protective Orders and Public Access to the Courts." *Harvard Law Review*, December 1991, *105*(2), pp. 427-501.

Nissen, Robert C. "Open Court Records in Products Liability Litigation Under Texas Rule 76a." *Texas Law Review*, March 1994, *72*(4), pp. 931-65.

Noe, Thomas H. and Wang, Jun. "Fooling All of the People Some of the Time: A Theory of Endogenous Sequencing in Confidential Negotiations." *Review of Economic Studies*, July 2004, *71*(3), pp. 855-81.

Porter, Michael E. "General Electric vs. Westinghouse in Large Turbine Generators (B)." *Harvard Business School Case 9-380-129*, 1980a.

_____. "General Electric vs. Westinghouse in Large Turbine Generators (C)." *Harvard Business School Case 9-380-130*, 1980b.

Porter, Michael E. and Ghemawat, Pankaj. "General Electric vs. Westinghouse in Large Turbine Generators (A)." *Harvard Business School Case 9-380-128*, 1980.

Rea, Samuel A., Jr. "Penalty Doctrine in Contract Law," in P. Newman, ed., *The New Palgrave dictionary of economics and the law* (Vol. 3). New York: Stockton Press, 1998, pp. 23-27.

Shavell, Steven. *Economic analysis of accident law.* Cambridge, MA: Harvard University Press, 1987.

Weiser, Benjamin. "Secret Settlement Shrouds Health Impact of Xerox Plant Leak." *The Washington Post*, March 13, 1989, p. A1.

Weiser, Benjamin and Walsh, Elsa. "Court Secrecy Masks Safety Issues: Key GM Fuel Tank Memos Kept Hidden in Auto Crash Suits." *The Washington Post*, October 23, 1988a, p. A1.

_____. "Hundreds of Cases Shrouded in Secrecy: Area Suits Often Sealed With Few Queries." *The Washington Post*, October 24, 1988b, p. A1.

_____. "Drug Firm's Strategy: Avoid Trial, Ask Secrecy; Records Reveal Story of Zomax Recall." *The Washington Post*, October 25, 1988c, p. A1.

_____. "Secret Filing, Settlement Hide Surgeon's Record; Questions Raised Over Patients' Deaths." *The Washington Post*, October 26, 1988d, p. A1.

Womeldorf, Rebecca A. and Cravens, William S.D. "More Sunshine Laws Proposed." *The National Law Journal*, November 12, 2001, p. B14.

Yang, Bill Z. "Litigation, Experimentation, and Reputation." *International Review of Law and Economics*, December 1996, *16*(4), pp. 491-502.

Yeazell, Stephen C. *Federal rules of civil procedure.* Boston: Little, Brown and Co., 1996.

FOOTNOTES

1. See the *Manual for complex litigation, third* (1995), section 21.431-432, for details on protective orders (which provide for sealing of discovery and subsequent materials). The *Manual*, which is published by the Federal Judicial Center, is a case management guide for judges. See Alan E. Garfield (1998) for a discussion of contracts of silence.

2. See Francis H. Hare, et al., (1988), a text for attorneys on obtaining/opposing confidentiality orders; they indicate that seeking such orders in products liability cases is "routine." See also Robert C. Nissen (1994).

3. See Boston Globe Investigative Staff (2002) on the employment of confidential settlements by the Catholic Archdiocese of Boston. Benjamin Weiser and Elsa Walsh (1988a,b,c,d) unearthed a number of examples wherein confidential settlements have been used, including: products liability in the automobile (GM's gas tank placement) and pharmaceutical (Pfizer's Feldene and McNeil's Zomax) industries; professional malpractice (by doctors, nurses, lawyers and hospitals); safety hazards in public facilities; and race- and sex-based employment discrimination cases.

4. An example of a firm paying for a credible commitment to openness is discussed in Michael E.

Porter and Pankaj Ghemawat (1980) and Porter (1980a,b); we return to this example in Section VI below.

5. See, for example, Jeffrey Collins (2002). Such court-instigated changes, and some recently-considered state "sunshine" statutes (with the exception of one enacted in Texas), generally do not apply to unfiled agreements (see Gale Group, 2003). Thus, contracts of silence with penalties for breach would likely still be enforceable.

6. In addition, some argue that using courts to resolve private settlement contract disputes implies a public right of access to judicial proceedings; see Doré (1999) and *Herrnreiter v. Chicago Housing Authority*, 281 F.3d 634 (7th Circuit) 2002, pp. 636-637.

7. Paul Milgrom and John Roberts (1986) first considered a formal model of a monopoly signaling unobservable quality via price and advertising; see also Mark N. Hertzendorf (1993), which assumes imperfectly-observed advertising. Some papers have considered quality signaling via price and adverstising when there are competitive forces, either because of entry deterrence considerations (e.g., Laurent Linnemer, 1998) or in response to existing rivalry (e.g., Hertzendorf and Per B. Overgaard, 2001, and Claude Fluet and Paolo G. Garella, 2002).

8. http://www.vanderbilt.edu/Econ/faculty/Daughety/SecrecyandSafetyWebAppendix.pdf

9. If this activity involves production of an alternative product, we assume that its sale takes place after the primary product has been sold. That is, consumers of the primary product cannot observe θ by monitoring the alternative activity prior to making their purchase decisions.

10. We also assume that the firm has a managerial capacity of N, so it will only run one "plant."

11. If harm is stochastic, but verifiable at settlement, then δ can be viewed as the expected harm.

12. This paper takes the liability regime as given. Although scholars, judges and policymakers have debated the desirability of "tinkering" with the system around the margins (e.g., with respect to

confidentiality, and various marginal re-allocations of liability through damages caps and fee-shifting), to our knowledge there is no serious contemplation of wholesale changes in the allocation of liability or in the use of settlement as alternative dispute resolution. There are many arguments that support allocating liability for harm to the firm (when its choices govern safety; see, e.g., Steven Shavell, 1987). Since the liability system is generated by broader considerations than are captured in our simplified model of a single market (and broader, even, than economic considerations), it seems appropriate to treat it as exogenous here.

13. Since settlement and litigation are represented by a complete information game, there will be no trials. Empirically, a high percentage of suits result in settlement (or are withdrawn); see Samuel R. Gross and Kent D. Syverud (1996) or Doré (1999). Theoretically, the model could be extended to allow for settlement bargaining failure, such as might result under asymmetric information (e.g., if the level of damages were private information for each plaintiff); see Bruce L. Hay and Kathryn E. Spier (1998) or Daughety (2000) for surveys of this literature. The possibility of trial would mean that even under confidentiality, there would be some possibility of consumers using this to update their estimate of θ, which would substantially complicate the analysis of the model; we abstract from this possibility.

14. Under the assumption of a large, but finite, number of consumers, the estimate of θ will be inexact. Alternatively, we could assume a continuum of consumers of measure N; in this case, the estimate of θ will be exact. While the model can accommodate either interpretation, we will treat the estimate of θ as exact, but continue to speak of N as the "number" of consumers because this is less technical and more intuitive.

15. Here D's disagreement payoff does not include effects on his continuation payoffs. None arise

in an open regime (or in Period 2 in either regime). We abstract from such effects in a confidential

regime as well, under the assumption that any <u>single</u> P choosing trial has a negligible effect on λ^C

and on the consumer's estimate of θ (e.g., trial establishes that D's product harmed this P, but does

not reveal the extent of others who might have been harmed). Alternatively, if D has all the

bargaining power, each P settles for her disagreement payoff (D's disagreement payoff is irrelevant).

16. For example, if there exists $\theta' > \theta$ such that $V - (1 - \theta)L^i - \beta\theta < 0$ for all $\theta \in [\underline{\theta}, \theta')$, then none

of the analysis below would change, provided that $\theta' < \theta^C$, a cutoff level to be determined in the

discussion of the incomplete information model of the confidentiality regime. If $\theta' > \theta^C$, that

analysis would be substantially more complex.

17. While consumers harmed in Period 1 who did not have viable suits are not constrained by a

confidentiality agreement, neither can they prove their harm was due to use of the product.

18. This condition is $-(V - \tilde{L}^C)\ln\{(V - \tilde{L}^C)/(V - \beta)\} - (\tilde{L}^C - \beta) + (t/N)((\tilde{L}^C - \beta)/\tilde{L}^C)^2 \geq 0$. This is a very

strong (but non-empty) sufficient condition, ensuring against the worst of the worst-case scenarios,

namely when μ is as small as possible (i.e., $\mu = t/N\tilde{L}^C$), making $\theta^C = 0$, and when $\bar{\theta} = 1$.

19. The practice continued from 1963 until the Justice Department objected and threatened suit in

1975. See Porter and Ghemawat (1980) and Porter (1980a,b).

20. But see Weiser (1989) for an example of the use of judicially-supervised sealing that prevented

information about leaks of trichloroethylene, a suspected carcinogen, by the Xerox Corporation's

Webster (NY) plant, into the groundwater. The court's sealing order on the settlement between

plaintiffs and Xerox limited the ability of victims to cooperate with public health agencies.

21. By "correct," we mean the same threshold as would be chosen by a social planner who is

constrained to the same timing and information as the firm, and is subject to the firm's subsequent

pricing behavior.

22. Confidential settlement recently figured in the Ford/Firestone product recalls. Rebecca A.

Womeldorf and William S. D. Cravens (2001) report that "One consequence of the recent Firestone

recalls has been a resurgence of legislative proposals aimed at ferreting out 'secrecy' in litigation."

23. These out-of-equilibrium beliefs ($b(p_2; \Theta) \in [\Theta, \bar{\theta}]$) assume that the retention decision was made

correctly, but an error in pricing occurred. If an error were made in retention instead, the firm has

the ability subsequently to choose the best price in the range of those expected by the consumer,

which would be $p_2^*(\Theta)$ for any $\theta_1 < \Theta$, at which a sale to the consumer is certain (and more profitable

than a sure sale at any $p_2 < p_2^*(\Theta)$). Thus, assuming that the probability of double-mistakes is zero,

it is reasonable to make this assumption about beliefs.