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PRODUCTS LIABILITY INSURANCE, MORAL HAZARD, AND CONTRIBUTORY NEGLIGENCE

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Products Liability Insurance, Moral Hazard, and Contributory Negligence *

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The foundation of an economic analysis of liability rules was laid by Coase[1/] in his now famous "irrelevance principle": resource allocation is independent of liability rules when there are no costs of transacting. Since the Coase Theorem, economists have grappled with the allocative implications of various exceptions to zero transaction costs.

It is useful to distinguish two types of transacting costs. In one, contracting is not feasible because the cost of identifying the parties in the transaction is prohibitive, as illustrated by the "exchange" between two speeding motorists. The role of liability rules in "involuntary exchange" has been thoroughly studied under various conditions.[2/] The other type of transaction cost arises because negotiating the terms of a contract in voluntary exchange is costly. Three varieties of contracting costs have been cited and analyzed in the literature. First, in a lively exchange among Buchanan,[3/] Calabresi,[4/] McKean[5/] and Oi,[6/] rules of products liability are contrasted under conditions of "adverse selection." Second, incorporating insights from the insurance literature,[7/] Shavell[8/] analyzes the effects of liability rules on resource allocation and consumer welfare when "moral hazard" is present. And third, the impact of "biased expectations" on the assessment of liability rules is explored by Spence[9/] and Epple and Raviv.[10/]

To date, the studies of contractual relations which have considered moral hazard have ignored biased information, and, conversely, those presuming biased information have ignored moral hazard. In the current paper, a model of the products liability insurance decision is constructed which includes both moral hazard and biased information. The effects of Consumer

Liability (CL) and Producer Liability (PL) are then compared. Also, the role of the Contributory Negligence (CN) defense in contractual relations has not been adequately articulated in the literature. The economic rationale for CN in noncontractual relations is that the party not liable under a straight Negligence of Strict Liability standard may not have the appropriate incentives to take cost-justified precautions. 11/ But in contractual relations the rule is superfluous unless moral hazard is present. Herein, the effect of CN on resource allocation is analyzed within a framework allowing for moral hazard.

In Section I, the moral hazard problem is illustrated for the simplest case of risk neutrality. PL and CL are compared, and the role of CN in reducing the cost of moral hazard is analyzed. Sections II and III make similar comparisons under more general conditions of risk aversion (Section II) and biased expectations (Section III).

I. Risk Neutrality

To depict the moral hazard problem in bold relief, many details of the insurance contract are ignored initially. The consumer is assumed to be oblivious to risk and to hold unbiased expectations. The producer-insurer is also risk neutral and provides actuarially fair insurance. For a given level of insurance coverage, β, the consumer maximizes expected income or, equivalently, minimizes the expected full price,

(1) $P(q) + W_X X + \beta [1 - \Theta (q,X')] L + (1 - \beta) [1 - \Theta (q,X)] L$

In (1), P is the product price, which depends on q, the inherent safeness of the product; $P_q > 0$ and $P_{qq} > 0$. The variable X measures the care exercised by the consumer, and W_X is the constant marginal cost of care. The function $\Theta(q,X)$ is the probability of "no accident"; it depends on q and X such that $\Theta_q > 0$, $\Theta_X > 0$, $\Theta_{qX} > 0$, $\Theta_{XX} < 0$, $\Theta_{qq} < 0$, and $\Theta_{XX}\,\Theta_{qq} - \Theta_{Xq}^{\;2} > 0$.

The specification in (1) accommodates moral hazard in a manner that requires some elaboration. The insurance premium, $\beta\,[1 - \Theta\,(q,X')]\,L$, depends both on the product safety purchased and on the insurer's anticipation of consumer care, X'. From the insured's perspective the insurance premium is independent of actual care.[12] But once the insured and insurer agree on a price of coverage, the insured has an incentive to shirk on his duty owed the insurer to act with the agreed upon care. For example, the marginal gain to care is $\Theta_X L$ when there is no insurance, but with coverage, β, this incentive is reduced to $(1-\beta)\,\Theta_X L$. If there is no way for the consumer to guarantee that he will adhere to the bargain, then the insurance premium will be driven up above what is in the interest of both the producer-insurer and the insured consumer.[13/] The reader may object that ex post settling-up schemes will be agreed upon to reduce the cost of moral hazard. And this is correct; but the rationale for such contract provisions is the subject of the paper. It is a major goal of this analysis to indicate when ex post settling-up schemes are efficient.[14/]

Minimizing (1) with respect to q and X leads to

(2a) $$P_q - \beta\,\Theta_q{}'\,L - (1 - \beta)\,\Theta_q\,L = 0$$

(?b) $$W_X - (1 - \beta)\,\Theta_X\,L = 0$$

Equation (2b) describes the insured's choice of care, X^a, given W_X, L, β and q; or $X^a = F(W_X, L, \beta, q)$. If moral hazard is rationally priced, the consumer's care is correctly anticipated by the insurer. The anticipated care, X', must be equal ex post to the level of care that solves (2b). Thus, equation (2a) is incorrect under the rational expectations assumption. Though the insured consumer does not consider ex ante the effect of his choice of X on the insurance premium, he will be forced to consider ex ante the effect of his choice of q on the premium directly via q's effect on Θ and indirectly via q's effect on X' and (X')'s effect on Θ. In the absence of any programs for monitoring the consumer or for settling up ex post with the consumer, moral hazard is rationally priced when (1) is minimized with F( ) substituted for X'. The insurance company charges the consumer ex ante for the ex post shirking he will commit.

An optimization problem analytically equivalent to minimizing (1) with F( ) substituted for X' is

(3) minimize $P(q) + W_X X + [1 - \Theta(q,X)] L$

subject to $W_X - (1 - \beta) \Theta_X L = 0$

(When $\beta = 0$, the constraint is not binding.) The marginal conditions associated with (3) are

(4a) $P_q - \Theta_q L = -\beta L \Theta_X \Theta_{Xq} / \Theta_{XX}$

(4b) $W_X = (1 - \beta) \Theta_X L$

If β were equal to zero, there would be no moral hazard; the marginal conditions in (4) would reduce to

(5a) $P_q - \Theta_q L = 0$

(5b) $W_X - \Theta_X L = 0$

which are identical to the marginal conditions that define the optimal X and q, (X^*,q^*). It is obviously futile to describe an optimum that only exists in the absence of conditions that are inevitable; but in the instant case, moral hazard is not inevitable, and it is useful for positive analysis of insurance contracts to describe the appropriate marginal conditions when moral hazard is not present.

It is clear that the expected full price is minimized when no insurance is purchased since (5a) and (5b) are the marginal conditions associated with minimizing the expected full price. Under the present conditions (risk neutrality, unbiased expectations, etc.), CL leads to the optimal solution, which entails no insurance and no moral hazard. Nevertheless, to acquaint the reader with the diagrams that appear later describing the minimum-cost level of insurance coverage under more general circumstances, the effects on the expected full cost of varying β are illustrated. The latter exercise is not irrelevant anyway if some insurance coverage is mandatory.

If (4a) and (4b) are solved for q and X in terms of β, W_X, and L, the following results obtain (assuming all third and higher order derivatives of Θ vanish):

(6a) $$\partial q/\partial \beta = - L\ \Theta_X\ (\Theta_X + \Theta_{Xq})/(1 - \beta)\ [P_{qq}\ \Theta_{XX} + L\ (\Theta_q\ \Theta_{XX} - \Theta_X \Theta_{Xq})] > 0$$

(6b) $$\partial X/\partial \beta = \Theta_X/(1 - \beta)\ \Theta_{XX} < 0$$

As β is raised, the consumer exercises less care than is optimal; the latter response alone tends to increase the expected accident cost. To offset this tendency, the inherent safety of the product is raised. It <u>cannot</u> be determined whether Θ increases or decreases with β.

The effect on the expected full price of increasing β is obtained by substituting the solutions to (4a) and (4b) into expression (1) and differentiating with respect to β:

(7) $$dP^{f'}/\beta = (P_q - \Theta_q\ L)\ q_\beta + (W_X - \Theta_X\ L)\ X_\beta$$

$$= (- \beta\ L\ \Theta_X\ \Theta_{Xq}/\Theta_{XX})\ q_\beta + (- \beta\Theta_X\ L)\ X_\beta > 0$$

As coverage increases, the overall effect of reduced care is to raise the cost of the product even though the increased safeness of the product lowers the expected accident cost, <u>ceteris paribus</u>.

In Figure 1 a diagrammatical illustration of the determination of optimal β is presented. The horizontal line $P^{f}**$ represents the minimum expected full price without moral hazard. It is drawn for reference. The function $P^{f}{}'$ is the minimum expected full price with moral hazard. The difference between $P^{f}{}'$ and $P^{f}**$ is defined as shirking cost, SC. Optimal insurance coverage is determined by minimizing $P^{f}** + SC$, which in the present circumstances occurs ar $\beta = 0$. In the more complex cases of Sections II and III, this same method is used of separating the components of cost and minimizing the sum to determine optimal β.

It is now clear what the effect would be of requiring mandatory insurance coverage. For example, with PL consumers would exercise less care than they would under CL; more safe, more expensive commodities would be produced; the full cost would be raised, and consumer welfare would be reduced. No prediction about the overall accident rate is forthcoming. Moreover, it is irrelevant to ask whether a move from CL to PL increases or decreases the accident frequency; what matters is that full price increases. Based on the foregoing analysis, it is difficult to explain, based on efficiency criteria, the demise of caveat emptor and the rise of Strict Liability in contractual relations.[15/]

The foregoing analysis has ignored the role of ex post settling-up schemes. Under caveat emptor there would not be a unique optimum with zero coverage if ex post settling-up schemes could be contracted costlessly. Of course, in the present circumstances there are no gains to insurance, and, strictly speaking, the consumer would be indifferent between no coverage and positive coverage with a costless ex post settling-up scheme. Nevertheless, it is instructive to illustrate in the simplest of cases what the effect of contingency clauses would be.

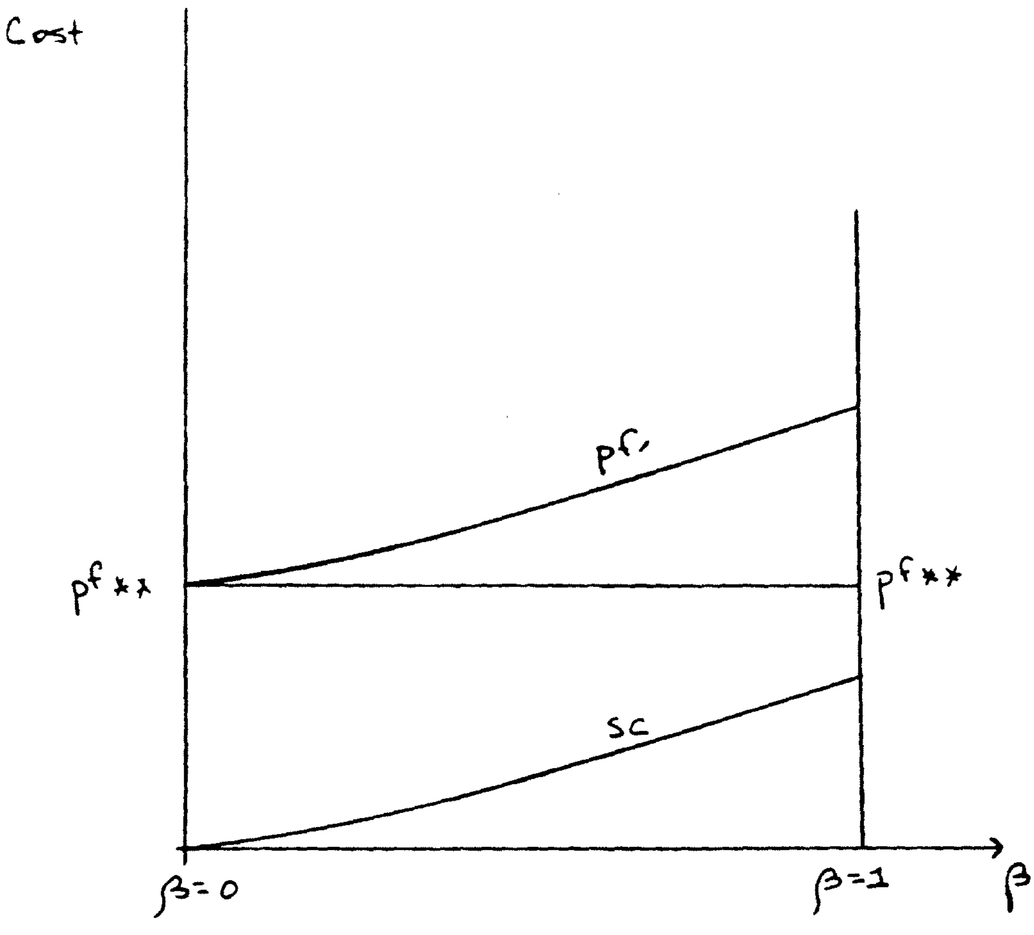

Figure 1

The type of ex post settling-up scheme studied is one that holds the insured fully liable for accident costs if $X < \overline{X}$, where $\overline{X}$ is a standard of care, and that provides the prearranged insurance coverage β if $X \geq \overline{X}$.

Generally, there are positive costs of enforcing the contingent liability clauses because information is not free. If information were costless, for each individual, $\overline{X}$ would be set equal to X*, the care exercised in the absence of moral hazard, and it could be freely ascertained ex post whether the individual met the agreed upon care. With costly information, some individual idiosyncracies are ignored in setting $\overline{X}$, and observed care may deviate from actual care. To simplify analysis, $\overline{X}$ is set equal to X* for each individual regardless of the cost of information. 16/ Modeling the costliness of determining the actual care exercised by the individual in the event of an oddicent requires further conceptual development.

It is supposed that measured care, X^m, is a function of actual care, X^a, and a random component: $X^m = g(X^a, u)$. For all $X^m < \overline{X} = X^*$, the expected value of the full price is

(8a) $EV|X^m < X^* \equiv P(q) + W_X X^a + \beta [1 - \Theta (q, X^*)] L$

$+ [1 - \Theta (q, X^a)] (L + c)$ and for $X^m \geq X^*$, the expected value of the full price is

(8b) $$EV|X^m \geq X^* \equiv P(q) + W_X X^a + \beta [1 - \Theta (q, X^*)] L + (1 - \beta) [1 - \Theta (q, X^a)] L + [1 - \Theta (q, X^a)] c$$

where it is assumed that c is the fixed cost of determining X^m. 17/

A risk neutral consumer minimizes

(9) $$(EV \mid X^m < X^*) [Pr(X^m < X^*)] + (EV \mid X^m \geq X^*) [1 - Pr(X^m < X^*)]$$

The solutions are more or less complex depending on what is assumed about the function $Pr(X^m < X^*)$. Generally, $Pr(X^m < X^*)$ is a function, $f(X^a;X^*)$, such that $f_{X^aV} < 0$. In the present paper, it is assumed that $f(X^a;X^*) \equiv \phi(X^a - X^*)$ and also that $\phi = 1$ for $X^a < X^*$ and $\phi = 0$ for $X^a \geq X^*$. This assumption drastically simplifies the optimization problem by ridding the model of some indeterminism; in effect $X^m = X^a$.[18/]

Based on the step function, ϕ, and fixed sampling cost, c, the consumer minimizes

$$(10a)\quad P(q) + W_X X + \beta\,[1 - \Theta(q,X^*)]\,L + [1 - \Theta\,(q,X)](L + c) \quad \text{for } X < X^*$$

and

$$(10b)\quad P(q) + W_X X + \beta\,[1 - \Theta(q,X^*)]\,L + (1 - \beta)[1 - \Theta(q,X)]\,L + [1 - \Theta(q,X)]c \quad \text{for } X \geq X^*$$

(Since $X^m = X^a$, the notation is simplified.) The method for determining the overall solution is to find solutions for (10a) and (10b) and then to choose the one that leads to the lesser value of (10a) and (10b).[19/]

For c = 0, the solutions are respectively, (X^*,q') and (X^*,q^*), where q' satisfies $P_q(q') - \beta\,\Theta_q(q',X^*)\,L - \Theta_q(q',X^*)\,L = 0$. Evaluating (10a) and (10b) at their solutions yields

$$(11a)\quad P(q') + W_X\,X^* + [1 - \Theta(q',X^*)]\,L\,(1 + \beta)$$

and

$$(11b)\quad P(q^*) + W_X\,X^* + [1 - \Theta(q^*,X^*)]\,L$$

Since (X^*,q^*) minimizes the expected full price and since (11a) contains the extra term $[1 - \Theta(q',X^*)]\,\beta$, (11b) < (11a). For c = 0, regardless of the level of mandatory insurance coverage, when a contingent liability clause is included in the insurance contract, the consumer chooses (X^*,q^*). Thus, if the defense of CN is allowed under PL, the full price of the product is lowered and the amount of care exercised by consumers is raised. The cost of moral hazard is completely eliminated.

For $c > 0$, the marginal conditions that define the consumer's choice of (X,q) when "negligent" and "not negligent," respectively, are

$$(12a)\quad P_q(q') - \beta\, \Theta_q(q',X^*)\, L - \Theta_q(q',X^*)\,(L + c) = 0$$

$$(12b)\quad P_q(\hat{q}) \qquad\qquad - \Theta_q(\hat{q},X^*)\,(L + c) = 0$$

20/

The cheaper of the solutions is that defined by (12b). The larger c is, the greater the excess of $\hat{q}$ over q^*; for $c = 0$, $\hat{q} = q^*$.

Figure 2 depicts the full price with shirking, $P^{f\prime}$, and the full price with the contingent liability clause described above, $\hat{P}^f$. PL without a defense of CN implies maximal shirking and a full price of $P^{f\prime}(1)$. With a defense of CN, the care is kept at X* and the full price is reduced to $\hat{P}^f(1)$.

Under some configurations of c and opportunities for shirking, $\hat{P}^f(1) > P^{f\prime}(1)$, and the full shirking solution would be cheaper than the no shirking solution. Though it is not strictly correct, it is almost correct to say that when the expected litigation cost, $(1-\Theta^*)\,c$, is high relative to the cost of shirking, firms would compete to establish a reputation for not invoking the CN defense. 21/ Consumers would ignore the standard of care and shirk maximally. Firms that breached the implicit contract by invoking the defense in the event of an accident would lose future customers. Thus, the CN rule never raises the expected full price and sometimes lowers it. An even stronger statement can be made. The expected full price includes the term $W_X X$, which would be difficult to measure. But even if a comparison is made between the sale prices, the analysis predicts that PL jurisdictions that bar the defense of CN will have higher sale prices. The latter follows because total accident avoidance cost is greater without shirking than with shirking. A similar comparison of PL jurisdictions with CL jurisdictions is difficult because in the

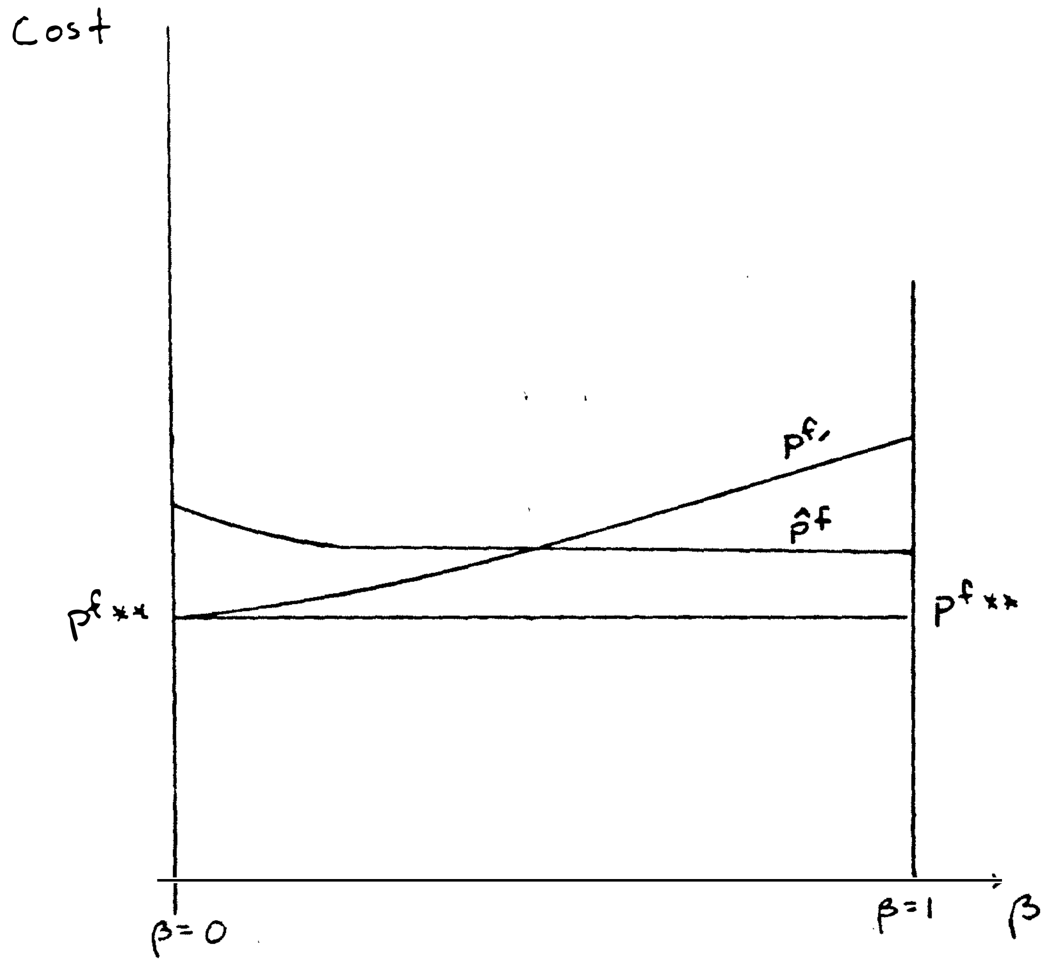

Figure 2

latter, the "insurance premium" is implicit and costly to measure. But since full price, not sale price, is the appropriate demand determinant, it is predicted that quantity demanded in CL jurisdictions is greater than in LB jurisdictions, ceteris paribus.

It is generally agreed that the role of CN in noncontractual tort cases is to assure that any accident-avoiding precaution that costs the injured plaintiff less than the expected accident cost avoided is taken.[22/] But in contractual cases, where the burden of liability is agreed upon ex ante, no rationale for CN has been given. In contrast, it is argued herein that the rationale for the CN rule is the attenuation of moral hazard.

In the next two sections, the model is generalized to include risk aversion and asymmetric information. In each case gains to insurance coverage are cited. As Zeckhauser[23/] observes in his analysis of the principal-agent problem associated with medical insurance, the optimal contract entails some positive amount of coverage less than 100 percent (or some finite deductible) in which the costs of shrinking are balanced against the gains of risk reduction. The analysis presented here is in one regard but a special case of Zeckhauser's model, which is more general in its assumptions about the insurer's risk preference and in its treatment of uncertainty; but in another sense the present analysis extends Zeckhauser's by emphasizing the role of voluntary contingent liability contracts, a market response to his damned-if-you-do, damned-if-you-don't quandary. Also, the effects of the mandated contingent liability clause, the CN rule, are analyzed.

II. Risk Aversion

There are conditions under which it would be expected that the market solution would entail some insurance coverage. Intuitively, if consumers are risk averse, then the cost of bearing risk per se is greatest without insurance, and this cost falls to a minimum with full coverage. There is a tradeoff, however; as insurance coverage grows the full price rises due to consumer shirking. Where these two costs are minimized lies the optimal insurance coverage. The optimal degree of coverage is obtained by maximizing the consumer's expected utility with respect to q, X and β subject to a constraint that embodies the reduced incentive the consumer has ex post to exercise care. The diagrammatical analysis that follows is based on the equivalent goal of minimizing the sum of (a) the "cost of risk," R, (b) the expected full price in the absence of shirking, P^{f}'', and (c) the shirking cost, SC. The analysis is only meant to be suggestive of the likely direction of impact on the optimal insurance contract of changes in various cost factors. A rigorous analytical treatment of the problem fails to yield unambiguous results. In some instances the cost of risk dominates the solution; in others, shirking cost is dominant. Before presenting the graphical illustrations, a detailed specification of the optimization problem is given.

The expression for the expected utility is

$$(13)\quad \Theta(q,X)\, U\{y - P(q) - W_X X - \beta\, [1 - \Theta(q,X')]\, L\}$$
$$+[1 - \Theta(q,X)]\, U\{ y - P(q) - W_X X - \beta[1 - \Theta(q,X')\, L]$$
$$- (1 - \beta)\, L\}.$$

If the insurance premium $\beta\,[1 - \Theta(q,X')]\,L$ is contracted for ex ante in the absence of any ex post settling-up scheme, then the consumer will maximize (13) as if his ex post care has no influence on the insurance premium. But no rational firm will provide insurance without accounting for the consumer's ex post shirking. Thus the maximization problem is altered in a way analogous to the adjustment cited for the risk-neutral case of Section I. The consumer maximizes (13) with respect to q,X and β subject to

$$(14) \quad \Theta_X\,[U(NA) - U(A)] - [\Theta\, U_Z(NA)\, W_X + (1-\Theta)\, U_Z(A)\, W_X] = 0,$$

where (14) embodies the correct prediction of the consumer's ex post shirking, which is found by diffentiating (13) as if X were constant in the expression for the insurance premium (NA and A indicate "no accident" and "accident").

Before determining the optimal insurance coverage diagrammatically, the equivalence of maximizing (11) with respect to q, X, and β, subject to (14) and minimizing $P^{f''} + SC + R$ is demonstrated. The first term, $P^{f''}$, is found by maximizing (13) with respect to X and q with X substituted for X', and evaluating $P(q) + W_X X + [1-\Theta(q,X)]L$ at the solutions. As such, the full price becomes a function of β. The resulting full price, $P^{f''}$, will be higher than P^{f**} (the minimum expected full price without moral hazard) for all $\beta < 1$ and will decline with β as the amount at risk falls; for $\beta=1$, $P^{f**} = P^{f''}$. The shirking cost, SC, is defined as the excess of the expected full price evaluated at the q and X that maximize (13) subject to (14), $P^{f'}$, over the optimal full price, $P^{f''}$. The cost of risk, R, is the maximum amount the consumer will pay to avoid risk. Thus, the cost of risk is the expected income with shirking, $y - P^{f'}$, minus the certainty equivalent, Z, of the uncertain income, found by solving $U(Z) = EU[q'(\beta),\ X'(\beta)]$ for Z, where $q'(\beta)$ and $X'(\beta)$ maximize (13) subject to (14).[24/] The sum of these three costs reduces to y - Z, which is minimized over β when Z is maximized over β, which in turn occurs where EU is maximized with respect to q, X and β subject to (14). Thus, the equivalence is established.

In Figure 3, $P^{f}**$ denotes the minimum expected full price without shirking and is drawn for reference only. The graph of P^{f}'' lies above $P^{f}**$ for $\beta < 1$, because with risk aversion the consumer would likely choose a more safe product and act more carefully than he would if he were risk neutral, and P^{f}'' coincides with $P^{f}**$ at $\beta = 1$ because his risk aversion is irrelevant when there is no risk. SC rises because the marginal gain to carefulness falls as β rises. Furthermore SC is drawn so that the sum of P^{f}'' and SC, which is P^{f}', rises with β. (Analysis fails to yield the latter result unambiguously.) The amount the consumer willingly pays to avoid risk, R, falls as the amount at risk falls. In the diagram, the minimum of the sum, $P^{f}'' + SC + R$, occurs at β^*.

The ambiguity revealed by an analytical treatment has an intuitive justification, which can be seen clearly in Figure 3. If there is little opportunity for the consumer to alter the accident probability through his own action, SC becomes an insignificant component of the sum. The minimum would then occur on the boundary, implying full coverage. At the other extreme, if shirking cost dominates the sum, the optimal amount of insurance may be zero. Thus, the agency cost model explains why consumers do not insure against all risks. This result contrasts with Shavell's,[25] which implies that without ex post settling-up schemes positive coverage is always purchased.

Based on Figure 3, CL and PL can be compared. CL allows the consumer to purchase the optimal insurance coverage. PL imposes above-optimal coverage on the consumer. The full cost of using the product is increased when consumers are not allowed to contract around the full coverage implied by PL.[26] As in Section I it will be shown that the rule of CN reduces the expected full cost of using the product when PL is imposed.

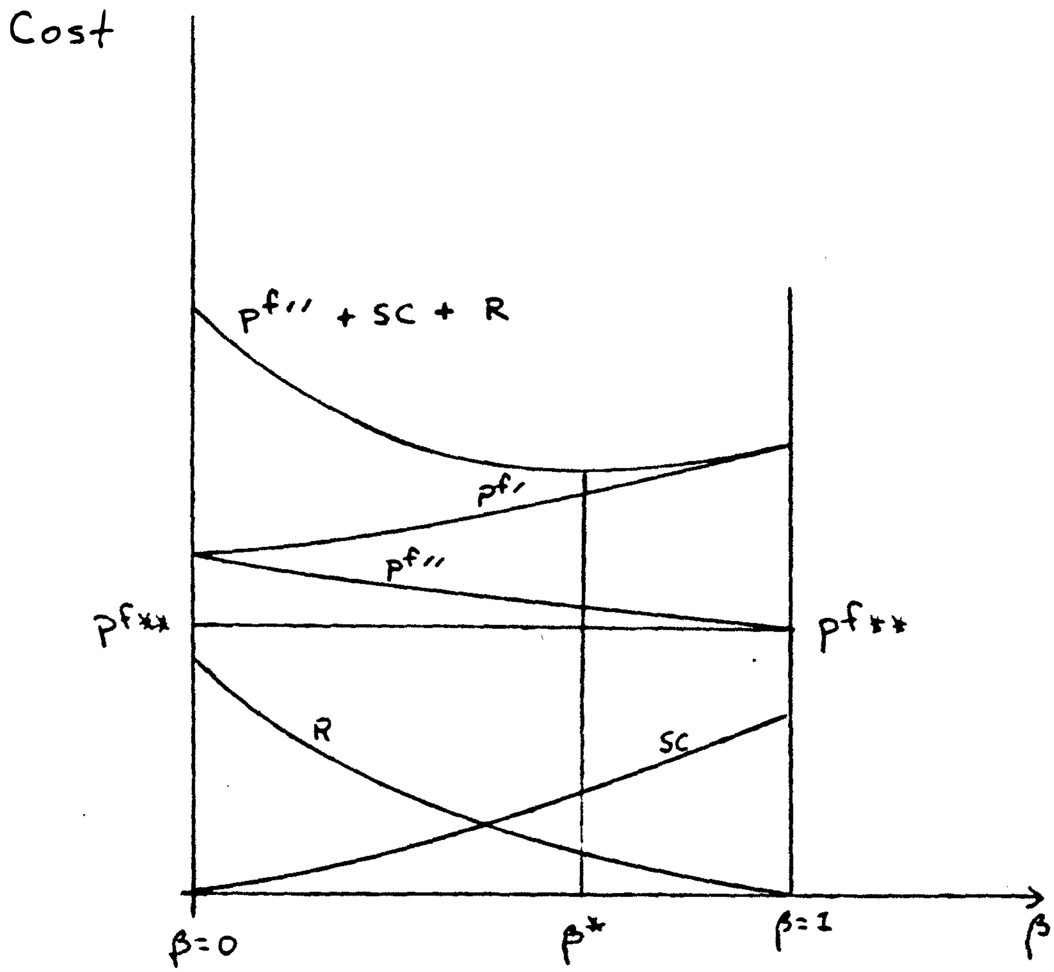

Figure 3

Under PL with a CN defense and assuming measured care equals actual care with fixed cost of sampling, the consumer maximizes

$$(15a)\quad \Theta(q,X)\, U\{y - P(q) - W_X X - [1 - \Theta(q,X^*)]\, L\} + [1 - \Theta(q,X)]\, U\{y - P(q) - W_X X - [1 - \Theta(q,X^*)]\, L - L - c\} \qquad \text{for } X < X^*$$

and maximizes

$$(15b)\quad \Theta(q,X)\, U\{y - P(q) - W_X X - [1 - \Theta(q,X^*)]\, L\} + [1 - \Theta(q,X)]\, U\{y - P(q) - W_X X - [1 - \Theta(q,X^*)]\, L - L + L - c\} \qquad \text{for } X \geq X^*$$

Maximum expected utility results in (15b) and since the constraint, $X \geq X^*$, is binding there for c small relative to L, the critical marginal condition is determined by maximizing (15b) with respect to q holding X constant at X^*:

$$(16)\quad P_q(\hat{q}) - \Theta_q(\hat{q},X^*)\, L = \Theta_q(\hat{q},X^*)\, [U(NA) - U(A)] / \{\Theta(\hat{q},X^*)\, U_Y(NA) + [1 - \Theta(\hat{q},X^*)]\, U_Y(A)\}$$

With full coverage and $c = 0$, $U(NA) = U(A)$, and (16) implies $\hat{q} = q^*$. As expected, with CN applied costlessly, the consumer chooses (X^*, q^*), and the expected full cost is equal to that which results under complete coverage without moral hazard. For $c > 0$, $U(NA) > U(A)$ [27]; $\hat{q}$ is chosen to exceed q^*; and the expected full price, $P(\hat{q}) + W_X X^* + [1 - \Theta(\hat{q},X^*)]\, L + [1 - \Theta(\hat{q},X^*)]\, c$, exceeds P^{f**}. For a fixed cost that is low relative to shirking cost, the expected full price will be lower under PL with CN than under PL without such a defense. And when c is high relative to the shirking cost, the defense will not be invoked. Thus, in general as in Section I, the effect of the defense of CN under PL is to lower the full cost of using the product and its sale price. Also, under the conditions posited, mandatory insurance (PL) is in general less efficient than CL, which does not bar consumers from purchasing insurance if the cost of moral hazard is not prohibitive. But, before the efficiency grounds for PL in products liability law can be ruled out completely, the most recently cited instance of "market failure" must be given a hearing.

Biased asymmetric information has been cited by some prominent economists [28/] as justification for a variety of forms of government intervention. Furthermore, the arguments of consumerist spokesmen, when interpreted most generously, also rest on the presumption of biased asymmetric information.

III. Biased Information

Insurance acts as a signal when consumer expectations are biased. The correct information about product safety held by the producer-insurer is conveyed by the insurance premium. The greater the degree of insurance coverage, the closer the consumer's objective function is to the true one. The presence of biased expectations apparently provides a justification for mandatory insurance coverage. It is admitted by proponents of government intervention, albeit reluctantly, that there may be market responses to the presence of asymmetric biased information such as voluntary certification and standardization and guarantees, but these are usually dismissed as inadequate. [29/]

The analysis of biased expectations to date has failed to incorporate moral hazard; [30/] and the analysis of moral hazard has failed to include biased expectations. [31/] When the two are combined there is a tradeoff occasioned by increased insurance coverage. Increased coverage signals the correct accident parameter, but it encourages shirking. As in the above analysis of risk aversion (Section II), the optimal degree of coverage is not generally full coverage.

A model to determine optimal insurance coverage which allows for biased expectations and moral hazard is constructed. The consumer's estimate of the accident parameter is assumed to be a function, π, of the true parameter, q.[32/] Most consumerists assume, at least implicitly, that $\pi(q) > q$; consumers overestimate product safety. In the specification below it is assumed that $\pi(q) = (1 + \alpha) q$ ($\alpha > 0$). In the latter specification there is "market failure" in the sense that relative to the information set of producers (insurers), mistakes are made by consumers in market equilibrium. Of course all gains from trade net of the cost of correcting the mistakes (conveying the information) will be exhausted in market equilibrium. It remains problematical whether political intervention can foster public welfare in such situations. The model will delineate some of the costs that have not been accounted for by proponents of government intervention as well as predict the implications of different liability rules under the posited conditions.

To concentrate on insurance as a signal, consumers are assumed to be risk neutral. Thus the consumer minimizes the following expected full price:

$$(17)\quad O[\pi(q),X]\,\{P(q) + W_X X + \beta\,[1 - \Theta(q,X')]\,L\}$$
$$+\{1 - O[\pi(q),X]\}\{P(q) + W_X X + \beta[1 - \Theta(q,X')]\,L + (1 - \beta)\,L\} = P(q)$$
$$+ W_X X + \beta\,[1 - \Theta(q,X')]\,L + (1 - \beta)\,\{1 - \Theta[\pi(q),X]\}\,L,$$

where X', the firm's correct anticipation of consumer care, satisfies $W_X - (1 - \beta)\,L\,O_X[\pi(q),X] = 0$.

If a further simplifying assumption is made about the form of Θ, the full cost of using the product can be divided into separate cost components and illustrated diagrammatically as in Sections I and II.

In particular if Θ is linear in q, then $\Theta(q + \alpha q, X) = \Theta(q,X) + \alpha\,\Theta(q,X)$, and the optimization problem equivalent to (17) is

(18) $$\text{minimize } P(q) + W_X\, X + [1 - \Theta(q,X)]\, L - (1 - \beta)\, \alpha\, \Theta(q,X)\, L$$

$$\text{subject to } W_X - (1 - \beta)\,(1 + \alpha)\Theta_X(q,X)L = 0$$

The perceived full price includes an additional term because of the biased expectations. For $\alpha > 0$, the consumer is not minimizing the "right" function unless $\beta = 1$, and for $\alpha > 0$, full coverage encourages maximal carelessness.

As in the previous diagrams, the total cost of using the product for a given level of coverage is equal to the sum of several components: in the current case, (a) the actual full price with bias and no moral hazard, P^{f*}, and (b) the shirking cost, SC, less (c) the bias term, B. In Figure 4, P^{f**} denotes the minimum expected full price without shirking and without bias. Without shirking but allowing for bias, the objective function in (18) is the appropriate minimand without constraint. The expected full price (not including the bias term) evaluated at the q and X that minimize the objective function in (18) is denoted P^{f*}. It lies above P^{f**} since the latter is the minimum expected full price for each β, and P^{f*} approaches P^{f**} as β approaches unity because the bias is less significant as β approaches unity. If shirking is allowed for, the minimization problem is that described in (18), and the expected full price (not including the bias term) evaluated at the solution values is denoted $P^{f\prime}$. The latter will coincide with P^{f*} at $\beta = 0$ because there is no shirking when the consumer self-insures. Strictly speaking, it cannot be deduced a priori that $P^{f\prime}$ rises as β rises. For low β there is more incentive to exercise care (even too much care since α raises the marginal gain to care for given β), but at the same time the minimand diverges further from the expected full price. Shirking cost, SC, is the difference between $P^{f\prime}$ and $P^{f}*$. In Figure 4, the shirking dominates so that $P^{f\prime}$ rises. To find B, the expression L $(1 - \beta)\ \alpha\ O(q,X)$ is evaluated at the q and X that solve (18). It is likely that B falls uniformly as β rises, as depicted in Figure 4, though the latter cannot be deduced a priori based on qualitative restrictions. For purposes of comparing the cost of CL and PL with and without CN, details about the form of B, for $0 < \beta < 1$, are unnecessary. It is known that $B = 0$ at $\beta = 1$ and that $B > P^{f}* - P^{f}**$ at $\beta = 0$.[33/]

Under the circumstances described in Figure 4, it is too costly for the biased expectations of consumers to be corrected through the market. The equilibrium level of coverage determined by voluntary agreement between consumers and insurers is always zero. This conclusion strictly follows only when B is a uniformly decreasing function of β. It is possible that B rises and then falls so that $P^{f}* + SC - B$ has a minimum at an interior β, as described by the curve P^{f}. In the latter case there is a significant tradeoff between -B and SC. Since no definite conclusions can be drawn about the form of B in the interior of the β interval, the present analysis looks only at the extreme cases of $\beta = 0$ and $\beta = 1$.

The above result is curious and warrants more comment. Producers offering the product and full insurance at the correct premium could not sell their package to risk neutral consumers with optimistic expectations. Will consumers and producers disagree forever? "Biased expectations" assumes implicitly that it costs the producer or some other firm too much to provide an information service to the consumer (perhaps because of the publicness of information) and the consumer's experience is too short to learn the true accident parameter.[34/] Modeling biased expectations

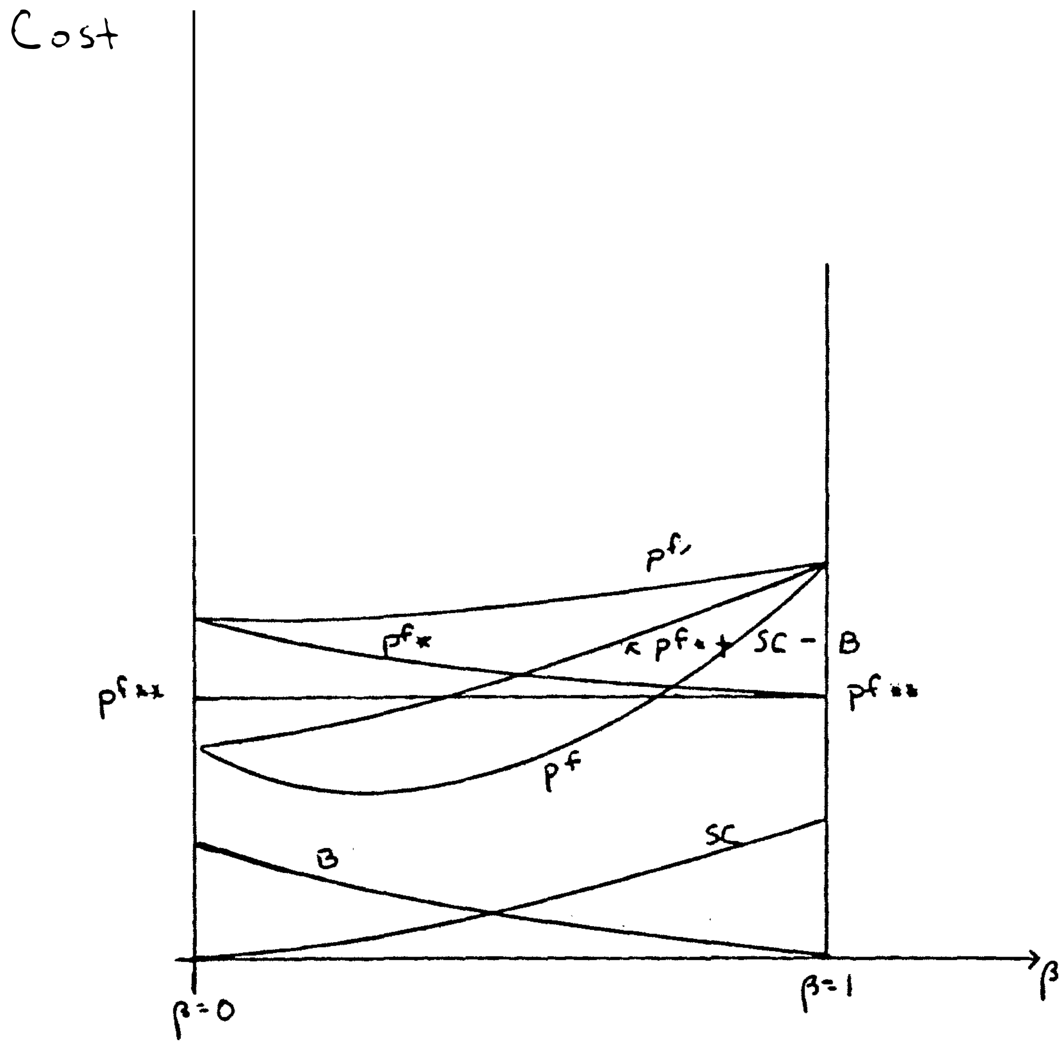

Figure 4

in a mechanical way begs these interesting questions. The present approach does not condone this procedure; but instead it is adopted in the spirit of meeting the proponents of such anomalies on their own turf.

Based on Figure 4, the true expected full price is higher under PL than under CL: $P^{f}{}'(1) > P^{f}{}'(0)$. Judicial legislation reduces consumer welfare. There may be circumstances however in which $P^{f}{}'$ declines as β rises. If opportunities for shirking are not extensive and if consumer bias is substantial, then the true expected full price under PL may be smaller than the true expected full price under CL. But, full coverage would never be voluntarily purchased, since the perceived full price is always lower at $\beta = 0$ than at $\beta = 1$. Thus, judicial intervention promotes consumer welfare when the cost of moral hazard is minor relative to the cost of biased information.

The ostensible justification, based on efficiency criteria, for government intervention under the present circumstances, is that information is available to some market participants which is too costly to convey to others through private exchange, and the transmittal of the information can be induced by government intervention at a sufficiently low cost. Obviously a model, which is cited to justify intervention, which does not include all market responses to costly asymmetric biased information is deficient. For example, voluntary certification, provided individually or collectively, is a familiar market response which has not been evaluated. Private certification is not treated here either; instead, the consumerists' case for intervention is met on its own grounds and still found wanting in many respects: There are configurations of moral hazard and information bias which make PL more costly than CL.

The role of the CN defense here is identical in effect to that in

Sections I and II. Based on the step function, ϕ, and fixed cost of sampling, c, and full insurance the consumer minimizes

(19a) $P(q) + W_X X + [1 - \Theta(q,X^*)] L + [1 - (1 + \alpha) \Theta(q,X)] (L + c)$

for $X < X^*$

and

(19b) $P(q) + W_X X + [1 - \Theta (q,X^*)] L + [1 - (1 + \alpha) \Theta(q,X)] c$

for $X \geq X^*$

Inspection of (19b) reveals that for $c > 0$ the effect of biased information is not eliminated by full insurance coverage. 35/

As in Section I the solution to (19a) is found by minimizing (19a) with X* substituted for X. 36/ Similarly, the solution to (19b) can be found by minimizing (19b) with X* substituted for X if the configuration of c and α cause the constraint in (19b) to be binding. 37/ For small c and small α this is likely. Thus the marginal conditions defining the solutions are

(20a) $P_q(q') - \Theta_q(q',X^*) L - (1 + \alpha) \Theta_q(q',X^*) (L + c) = 0$

(20b) $P_q(\hat{q}) - \Theta_q(\hat{q},X^*) L - (1 + \alpha) \Theta_q(\hat{q},X^*) c = 0$

These equations imply that $\hat{q} < q'$. It remains to determine how the perceived full prices of (19a) and (19b) compare when evaluated at the solutions, (X^*,q') and $(X^*,\hat{q})$, respectively. Clearly if c were zero, then (19b) < (19a) because the sum of the first three terms of (19b) is less than the sum of the same three terms in (19a), since $\hat{q}$ is closer to q* than q' is. But when $c \neq 0$, it appears that $[\Theta(q',X^*) - \Theta (\hat{q},X^*)] (1 + \alpha) c$ may be greater than $[1 - (1 + \alpha) \Theta(q',X^*)] L$, so that (19a) may be less than (19b). 38/ The latter is more likely when c or α is large, given L. For moderate bias and c small relative to L, the solution will be $(X^*,\hat{q})$.

What has been demonstrated is that the true expected full price with PL and CN will be the lesser of $P^{f}{}'(1)$ and (19b), since competition among firms assures that the CN defense will not be invoked if it raises cost above the shirking solution. As in Sections I and II the role of CN is to lower the full price when PL is imposed.

The difference between the implications of biased information and unbiased information is that PL will not necessarily raise full cost on average when expectations are biased. The reason for this is that under CL consumers with biased expectations do not perceive the true cost of self-insurance and will not voluntarily purchase sufficient insurance. CL does not unambiguously reduce the full cost below that which obtains under PL when expectations are biased.

Conclusion

Based on a choice model of products liability insurance, which accommodates moral hazard, and alternative assumptions about risk aversion and the quality of product-safety information, several liability rules are compared. It is shown that regardless of risk aversion, if consumers hold unbiased information about product safety, Producer Liability implies lower consumer welfare than Consumer Liability. When consumer information is biased, the effect of Producer Liability on consumer welfare is ambiguous and depends on the importance of moral hazard relative to information bias. It is further shown that regardless of risk aversion or the quality of product-safety information, allowing the defense of Contributory Negligence raises consumer welfare in Producer Liability jurisdictions. Thus is articulated an economic rationale for application of the Contributory Negligence rule in contractual relations which heretofore has not been adduced. Contributory Negligence is a type of contingent liability clause that lowers the cost of moral hazard.

In a more positive vein, based on the method of defining consumer welfare as the sum of full-price components expressed in monetary equivalents, the prediction is derived that Contributory Negligence lowers the sale price of commodities in Producer Liability jurisdictions. A similar comparison of prices between Consumer Liability and Producer Liability jurisdictions is impossible because the insurance component of full price is only implicit under Consumer Liability. However, since full price co-determines quantity demanded, it is implied, <u>ceteris paribus</u>, that less is purchased in jurisdictions applying Producer Liability without Contributory Negligence than in jurisdictions applying Producer Liability with Contributory Negligence, and less is purchased in the latter than in jurisdictions applying Consumer Liability.

Footnotes

*The comments of Paul Rubin, Roger Sherman, Chester Spatt and an anonymous referee are gratefully acknowledged.

1. See Ronald Coase, The Problem of Social Cost, 3 J. Law & Econ. 1 (1960).

2. See John P. Brown, Toward an Economic Theory of Liability, 2 J. Legal Stud. 323 (1973); G. Calabresi, The Decision for Accidents: An Approach to Nonfault Allocation of Costs, 78, Harv. L. Rev. 713 (1965); P. Diamond, Accident Law and Resource Allocation, 5 Bell J. Econ. & Management Sci. 366 (1974); J. Green, On the Optimal Structure of Liability Laws, 7 Bell J. Econ. & Management Sci. 553 (1976).

3. J. M. Buchanan, In Defense of Caveat Emptor, 38 U. Chi. L. Rev. 64 (1970).

4. See H. G. Manne, Edited Transcript of AALS-AEA Conference on Products Liability, 38 U. Chi. L. Rev. 117 (1970).

5. R. N. McKean, Products Liability: Implications of Some Changing Property Rights, 84 Quart. J. Econ. 611 (1970).

6. W. Oi, The Economics of Product Safety, 4 Bell J. Econ. & Management Sci. 3 (1973).

7. See K. Arrow, Uncertainty and the Welfare Economics of Medical Care, 53 Am. Econ. Rev. 941 (1963); M. Pauly, The Economics of Moral Hazard: Comment, 58 Am. Econ. Rev. 531 (1968) and Overinsurance and Public Provision of Insurance, 68 Quart. J. Econ. 44 (1974); S. Shavell, Accidents, Liability and Insurance, Discussion paper, Harv. Inst. Econ. Res. (1979); R. Zeckhauser, Medical Insurance: A Case Study of the Tradeoff Between Risk Spreading and Appropriate Incentives, 2 J. Econ. Theory 10 (1970).

8. S. Shavell, On Moral Hazard and Insurance, Discussion paper 557, Harv. Inst. Econ. Res. (1977).

9. M. Spence, Consumer Misperceptions, Product Failure and Producer Liability, 44 Rev. Econ. Stud. 561 (1977).

10. D. Epple and A. Raviv, Product Safety: Liability Rules, Market Structure, and Imperfect Information, 68 Am. Econ. Rev. 80 (1978).

11. See R. A. Posner, A Theory of Negligence, 1 J. Legal Stud. 305 (1972).

12. Pauly's (see Pauly (1974) supra note 7) treatment of moral hazard is analytically equivalent, but his rationale for supposing the insurance premium is independent of care in the insured's optimization is "large numbers": In effect, an individual's premium per unit of coverage is an average over total coverage of the total expected payout, which is affected less by an individual's care than the probability of an accident particular to him is. Here, it is explicitly a problem of contracting which leads to moral hazard.

13. See E. Fama, Agency Problems and The Theory of the Firm, U. Rochester Working Paper (1978) and M. Jensen and W. Meckling, Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure, 3 J. Fin. Econ. 305 (1976).

14. Monitoring is an alternative to ex post settling-up schemes (see D. Wittman, Prior Regulation vs. Post Liability: The Choice Between Input and Output Monitoring, 6 J. Legal Stud. 193 (1977)). But in the current paper, monitoring is ignored because it is not considered an efficient method of reducing the cost of moral hazard in products liability insurance contracts.

15. From a political economist's perspective it may be noted that though producers do not gain, the insurance industry and the courts have more

business. Another prominent group that gains is unionized labor in the service industries because, to the extent that producer liability raises the cost of using products, consumers are driven into the market for professional services.

16. Contingent liability clauses may be voluntarily contracted between insurer and insured under CL. When PL applies, an ex post settling-up scheme may be mandated by the legislature or the courts. When mandated, it is known as the rule of Contributory Negligence (CN). Even with free information it may seem unlikely that a court-made standard would equal X^*, but the literature on the efficiency of the common law supports this presumption (see P. Rubin, Why Is The Common Law Efficient?, 6 J. Legal Stud. 51 (1977), and G. Priest, The Common Law Process and the Selection of Efficient Rules, 6 J. Legal Stud. 65 (1977)).

17. Assuming that consumers cannot insure against the "litigation loss," c, when $X < X^*$ and there is no accident, the consumer pays $P(q) + W_X X + \delta [1 - \theta (q,X^*)] L$, and when $X < X^*$ and there is an accident, the consumer pays $P(q) + W_X X + \delta [1 - \theta (q,X^*)] L + L + c$. The expression in (8a) is the expected value of these contingencies. Similarly, when $X \geq X^*$ and there is no accident, the consumer pays $P(q) + W_X X + \delta [1 - \theta (q,X^*)] L$ and when $X \geq X^*$ and there is an accident, he pays $P(q) + W_X X + \delta [1 - \theta(q,X^*)] L + L - \delta L + c$. The expected value of these outcomes is given in (8b). Specifying (8a) and (8b) differently to allow for litigation insurance does not alter the overall assessment of CN.

18. In a more general context with ϕ a declining function of $X^a - X^*$ such that $\phi < 1$ for a range of $X^a < X^*$ and $\phi > 0$ for a range of $X^a \geq X^*$, the consumer may choose $X^a > X^*$ to increase the likelihood that he is found "not negligent" in the event of an accident. More importantly,

with : specified more generally, (9) does not adequately describe the risk averse consumer's optimization problem, unless he is also being fully insured against the risks of erroneous judgments. Of course, moral hazard inheres in the latter type of insurance contract. Furthermore, in all cases where the producer-insurer is risk averse there will be an optimal sharing of accident risk and the risk of erroneous judgments. (An annonymous referee has suggested astutely that Comparative Negligence may have replaced CN in many jurisdictions, to deal with risk sharing.) These more complicated problems are the subject of the principal-agent models of Mirrlees, Ross, Harris and Raviv, and Holmstrom. (See J. Mirrlees, The Optimal Structure of Incentives and Authority Within An Organization, 7 Bell J. Econ. & Management Sci. 105 (1976); S. Ross, The Economic Theory of Agency: The Principal's Problem, 63 Am. Econ. Rev. 134 (1973); M. Harris and A. Raviv, Some results on Incentive Contracts, 68 Am. Econ. Rev. 20 (1978); and B. Holmstrom, Moral Hazard and Observability, 10 Bell J. Econ. & Management Sci. 74 (1979).) More to the point of the current paper, Shavell (see Shavell, supra note 8) analyzes moral hazard and liability rules in this context. But he is not concerned directly with the Contributory Negligence defense, and he does not consider biased expectations.

19. Strictly speaking (10a) has no solution. This follows because it can be shown that in the amended problem

(10a') minimize $P(q) + W_X X + \beta\,[1 - \theta\,(q,X^*)]\,L + [1 - \theta\,(q,X)]\,(L + c)$

for $X \leq X^*$

the constraint is binding. Proof entails a comparison of the marginal conditions that determine (X^*,q^*) and those associated with minimizing (10a) without constraint. The solution to the latter problem occurs at

$X > X^*$. Thus, requiring that $X < X^*$ always constrains the consumer from choosing the best combination of care and safety. Because the solution to (10a') is the limit point to the set of solutions to the problem, minimize (10a) subject to $X \leq X''$ for all $X'' < X^*$, it is reasonable to call the solution to (10a') the solution to (10a).

20. Equation (12a) defines the q solving (10a) regardless of the size of c since it can be shown that in (10a') [(10a)] the constraint is binding for all c. But (12b) is correct only for c small relative to L, given β; or for given c and L, (12b) is appropriate for "high" coverage. The reason for this is that c and β affect the marginal gain to care in opposite directions. Thus, reduced coverage may raise the marginal gain to care so much that, given c, the appropriate level of care is greater than X^*. Then, the constraint in (10b) ceases to bind so that (10b) is no longer solved by simply replacing X by X^* and optimizing over q. The range of β over which (12b) is appropriate is larger, the smaller c is. Since the important comparison is between PL with CN and PL without CN, cases in which $\beta = 1$, it is likely that c is sufficiently small relative to L to make (12b) the correct marginal condition.

21. It is not strictly correct because the full prices, $\hat{P}^f$ and $P^{f\prime}$, differ not only because $\hat{P}^f$ alone includes the expected litigation cost and $P^{f\prime}$ alone entails shirking. More exactly, whenever $c > 0$, a choice of $\hat{q} > q^*$ alters the other terms in the expression for the expected full price so that a comparison between $\hat{P}^f$ and $P^{f\prime}$ is necessary, not just a comparison between shirking cost and litigation cost.

22. See Posner, supra note 11.

23. Zeckhauser, supra note 7.

24. Berhold calls this quantity the risk aversion increment, I (see M. Berhold, A theory of Linear Profit Sharing Incentives, 85 Quart. J.

Econ. 462 (1971)).

25. Shavell, <u>supra</u> note 8.

26. Courts will allow parties to contract around the law in cases only where it is clear that both parties have equal bargaining power and negotiate freely. For example, producers cannot present disclaimers to limit liability in a standard printed contract in products liability law, and in some cases consumers are not allowed "assumption of risk" even when explicitly agreed to.

27. This assumes that the consumer cannot buy actuarially fair insurance against litigation losses. If PL entailed full insurance against this contingency as well, whenever $X \geq X^*$, the maximand would be $U\{y - P(q) - W_X X - [1 - \theta(q,X^*)](L - c)\}$ and the marginal condition defining the optimal (X^*,q) would be identical to (12b) in Section I. Thus, the different assumptions about the insurability of litigation losses only matter when the consumer is risk averse.

28. See H. Leland, Minimum Quality Standards in Markets with Asymmetric Information, Conference on Occupational Licensure and Regulation, AEI (1979) and Quacks, Lemons and Licensing: A Theory of Minimum Quality Standards, 87 J. Pol. Econ. 1328 (1979); Spence, <u>supra</u> note 9.

29. See Leland (1979a), <u>Ibid</u>.

30. See Epple and Raviv, <u>supra</u> note 10 and Spence, <u>supra</u> note 9.

31. See Pauly, (1974) <u>supra</u> note 7 and Shavell, <u>supra</u> note 8.

32. See Spence, <u>supra</u> note 9.

33. The latter is easily proven by forming the derivative with respect to α of the perceived full price evaluated at $\alpha = 0$, assuming that $\beta = 0$ and that X and q are chosen optimally according to (18). The result is $-\theta(q^*,X^*)L$, which indicates that the perceived full price (less the

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29. See Leland (1979a), <u>Ibid</u>.

30. See Epple and Raviv, <u>supra</u> note 10 and Spence, <u>supra</u> note 9.

31. See Pauly, (1974) <u>supra</u> note 7 and Shavell, <u>supra</u> note 8.

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33. The latter is easily proven by forming the derivative with respect to α of the perceived full price evaluated at $\alpha = 0$, assuming that $\beta = 0$ and that X and q are chosen optimally according to (18). The result is $- \theta(q^*,X^*) L$, which indicates that the perceived full price (less the

bias is reduced by raising α, and since the actual and perceived full price equal P^{f**} for $\alpha = 0$ and $\beta = 0$, the perceived full price must be below P^{f**} for $\beta = 0$ and $\alpha > 0$.

34. The latter seems reasonable in many instances on its face; but the fund of past consumers' experiences is a valuable source of information, as well. The biased-expectations hypothesis implicitly assumes it is prohibitively costly to convey the message of such experience.

35. If litigation losses were also insured at actuarially fair rates, (19b) would reduce to $P(q) + W_X X + [1 - \theta\ (q, X^*)]\ (L + c)$, and the role of bias would be completely eliminated through full coverage.

36. See note 19, <u>supra</u>.

37. See note 20, <u>supra</u>.

38. This ambiguity would vanish if litigation insurance were bought at actuarially fair rates.